THURSDAY, JUNE 10, 1880

"OLD NORWAY"

Die Geologie des südlichen und mittleren Norwegen. Herausgegeben von Dr. Theodor Kjerulf; autorisirte deutsche Aufgabe von Dr. Adolf Gurlt. (Bonn: Max Cohen und Sohn, 1880.)

IN that rugged northern land where the mingled Atlantic and Arctic tides course round a network of islands, and lave the shores of deep lonely fjords, sending their waters far inland to the very base of snowfield and glacier, the people, with the patriotism of mountaineers, sing enthusiastically of "Gamle Norge"—Old Norway. And well may they sing of a land that by its scenery and climate has moulded their habits of thought, their traditions, their literature, and has knit their bodily frames into that muscular type for which the hardy Norsemen have been famous from time immemorial. Dear Gamle Norge! The sound of its praise awakens a responsive chord in the breast of many a Briton, leading him to reflect how much of the vigour and success of his own countrymen may be due to the fresh blood which came to them from the robust north, and reminding him of the wild creed and spirit-stirring songs which his ancestors shared with their kinsmen of the northern fjords. Well may men speak of "old" Norway. Even as regards human records, its antiquity goes back far enough to merit that appellation. But if we pass to the earlier history of Europe the fitness of the epithet becomes singularly impressive. To that northern region of tableland and valley the geologist looks as the cradle of this continent. The plains of Russia and Germany are formations but of yesterday. The Urals, the Alps, the Pyrenees, the high grounds of Bohemia, Saxony, and Central France have appeared at various widely separated epochs, and have undergone many vicissitudes in a long course of ages. But the uplands of Scandinavia, though they too have not been without their mutations, already existed as land almost at the beginning of those ages which are chronicled in the rocky records of the earth's crust. From the sand and mud washed down from these uplands the formations have been derived out of which, for example, most of the highlands of Scotland, Wales, and Ireland have been built up. So far as we can tell, the earliest land of Europe rose in the north and north-west. The subsequent growth of the continent has been over the tract of shallow sea by which the first land was bounded.

There is thus a peculiar interest in the study of the geological structure and history of Scandinavia. It is in that region that by far the largest fragment of archæan Europe exists and that the data are chiefly to be sought from which the earliest chapters of European geological history must be written. Most cordially, therefore, will all geologists welcome the volume which Dr. Kjerulf has just published for their information. It is by much the most important summary of Norwegian geology which has yet appeared.

In an interesting preface a sketch is given of the progress of geological inquiry in Norway. After numerous private and unconnected researches by natives and foreigners in different parts of the country, a systematic geological survey of the country was in 1858 projected by Dr. Kjerulf and Bergmeister Tellef Dahll, and on the approval of the plan by the Norwegian Government, was commenced at the national expense. Its main object was to make a geological map of the country with the requisite sections. The Survey was organised very economically under Kjerulf and Dahll, with no special office, no place to store specimens, no laboratory, and no official channel of publication for its memoirs. With praiseworthy enthusiasm the two geologists continued for ten years to work in the field during the brief Norwegian summers, either together or singly, taking with them as volunteer assistants such students of mining and others as chose to accompany them. In 1866 Dahll undertook the investigation of Northern Norway, so that the charge of the Central and Southern provinces then fell to Kjerulf. The latter geologist, with the assistance of other observers, whose share in the work is duly chronicled, has at intervals published maps and sections of the area under his control, and in particular a general map on the scale of one-millionth. As a fit conclusion to the labours of a quarter of a century among the geological formations of Norway, he has published at Christiania a quarto volume with an atlas of plates, giving a concise account of the geological features of the central and southern part of the country.[1] This work is in Norse; but the author, with the view of making it more widely known, has intrusted it to Dr. Gurlt, who has rendered it successfully into German, and has had it republished in a convenient form.

Every student of metamorphism and the crystalline schists must procure Dr. Kjerulf's work. It contains a store of facts of the utmost importance for all theoretical questions in this most interesting and difficult department of geology. At the same time the superficial geology is not neglected. The first part of the volume treats of the loose surface formations—especially of the erratic blocks, moraines, and glacial striæ. These phenomena are illustrated by maps, on one of which—that of the striated rock-surfaces—an explanatory remark affords a characteristic sample of the author's cautious spirit of observation:—"The directions of the striæ are expressed on the map, as in nature, by lines; the observer must himself judge whence they come and whither they go." The second part, devoted to a summary of the geology of the Christiania district, contains a table of fossiliferous deposits, which, extending from the base of the Primordial zone to the top of the Upper Silurian formations, are shown to attain there a thickness of 2,700 feet. There is likewise an important tabular statement of the horizons of the leading organic remains of these older palæozoic deposits. In Part III. a description is given of the "Grundgebirge," or fundamental rocks of Southern Norway. The author shows that though these have sometimes been classed under the general term gneiss, they contain other rocks, especially various schists, quartzites, conglomerates, and limestones, and that gneiss is rather a structure belonging to rocks of different ages than a formation of one geological date. He regards the bottom gneiss as a metamorphic representative of ordinary sedimentary formations, in

[1] "Udsigt over det Sydlige Norges Geologi" (Christiania, 1879).

particular of the so-called "Sparagmite" or fragmental accumulations below the Primordial zone. He believes that the older gneiss may include metamorphosed portions of younger formations, in particular considerable masses of the Primordial rocks. This question in another form is discussed in Part IV., which treats of the geology of Central Norway. To the oldest sedimentary formations, termed the Sparagmite series, a thickness of 2,300 Norwegian feet is there assigned. They consist of sandstones, conglomerates, schists, slates, and limestones. Above them lie the Primordial beds, 2,900 feet thick, composed of quartz-schists, mica-schists, "blue-quartz," sandstones, clay-slates, and limestones, among which are found the earliest fossils (*Dictyonema*, *Olenellus*, &c.). Above these rocks the unfossiliferous red sandstones and conglomerates of the west coast (? Old Red Sandstone), long since described by Naumann, close the geological record until the deposits of the Glacial period. Dr. Kjerulf brings forward many facts regarding the metamorphism of the older palæozoic rocks in Central Norway, and traces with clearness the passage of these rocks into schistose and gneissose masses as they approach the larger areas of granite. Part V. is devoted to a brief exposition of the geology of the Trondhjem district. Part VI. discusses the lithology of the eruptive rocks. The various species and varieties of granite, syenite, porphyry, gabbro, greenstone, olivine-rocks, &c., are here described with remarkable succinctness alike as to their composition and geological relations. Considering the meagreness of the official equipment of the Geological Survey, this portion of their work must be admitted to be specially creditable to the Norwegian geologists. In Parts VII. and VIII. information is given regarding the structure of rocks and mineral veins. Some nature-printed illustrations of rock-structure here inserted are interesting. Slices of foliated, graphic, and porphyritic granite, etched with hydrofluoric acid, have allowed the more durable quartz to print its figure upon paper, and the impression has then been photographed on wood and cut into a woodcut. Some figures are also added to show the coexistence of organic remains (graptolites, corals) with crystals of chiastolite, vesuvianite, and other minerals in metamorphosed Silurian rocks.

A useful feature in the German translation is the addition of an index, which is wanting in the original, but which would have been still more acceptable had it been even fuller than it is. The numerous woodcut sections enable a reader to follow the local descriptions in the text. But the addition of a good geological index-map, such as that which accompanies the Norwegian volume, would have been of much service, and might perhaps have been given without any very serious increase of price. But this is a defect which every geological reader, at a little cost to himself, can remedy by obtaining the general map. He will find in Dr. Gurlt's version of Dr. Kjerulf's memoir an invaluable compendium of Norwegian geology, and will probably be induced to set out himself to make a personal exploration of the sections which are therein described. Should he be induced so to do he will doubtless come to look back on his tour in Norway as one of the most instructive as well as delightful of all his geological rambles.

ARCH. GEIKIE

EUCALYPTOGRAPHIA

Eucalyptographia; being a Descriptive Atlas of the Eucalypts of Australia and the Adjoining Islands. By Baron F. von Mueller, K.C.M.G., M. and Ph.D., F.R.S., Government Botanist for the Colony of Victoria. Decades 1 and 2. (Melbourne and London, 1879.)

MATERIAL for the issue of this atlas was accumulated at Melbourne now over thirty years ago, and the study of this fine group of the myrtles has been carried on ever since, as opportunities presented themselves by Dr. Mueller. Still the subject was so large and the perplexities surrounding it so many that even now he offers his observations in these decades as only fragments toward a some day complete monograph. The difficulties surrounding the study of this group are many. There is the large number of species, the genus Eucalyptus being surpassed in this respect only by Acacia. The resemblance of many specific forms is apt to deceive one; the fruits, and more especially the flowers, are often far out of the reach of the ordinary traveller, even though he might in his enthusiasm not object to climb for a considerable height into the trees; and then the species themselves are widely distributed over the whole of the Australian continent and Tasmania, some even extending to the Indian Ocean Islands, though, it may be added, none occur in New Zealand.

Mr. Bentham's grouping of the species has been, with some trifling modifications, adopted by the author, and the Government of West Australia has borne the expense of issuing these two decades, which contain descriptions of some of the most important timber trees of the great western colony. It is to be hoped that some of the other colonial governments may follow this good example, and so help on the publication of the work. Perhaps even our own Royal Society might see their way to help it by a grant in aid out of the fund placed at their disposal by Parliament for promoting scientific research.

The economic value of these eucalypts needs scarcely to be insisted on. Not only do they yield excellent hard timber, but as products we find enumerated oils, tars, acids, dyes, tan, and potash. What magnificent forest trees are to be found among them will appear from the description of some of the species figured in these parts. One (*E. goniocalyx*) is mentioned as growing on low or hilly woodlands up to about 3,000 feet, and attaining in some of the forest valleys a height of 300 feet, with a stem diameter of not rarely six feet, and sometimes even ten. The timber of this species is described as hard and tough, exceedingly durable, lasting well when buried underground, not warping, and difficult to split. Another species (*E. leucoxylon*) known as the iron bark tree, or white gum tree, grows to a height of 200 feet, has a timber of great hardness, durability, and of extraordinary strength. On being burnt for charcoal it yielded 28 per cent. of superior stuff, 45 per cent. of crude pyroligneous acid, and 6 per cent. of tar. An excellent packing paper has been prepared from the inner layers of the bark, as can indeed be done from the inner bark of most eucalypts, and the leaves yield a volatile oil to the extent of about 1 per cent.

The genus thus abounding in useful products is not

wanting either in remarkable forms; thus *E. alpina* is found only on the summit of Mount William, Victoria, at an elevation of over 4,000 feet, and its area is limited to the top of this one peak, for it does not even extend to any of the other summits of the chain of which Mount William is the culminating point. This species has been cultivated in the Melbourne Gardens from seeds collected in 1853, but even in good soil it retains a dwarf bushy habit, having in a quarter of a century not grown over a dozen feet in height, and showing little tendency to form a distinct stem. This species offers, perhaps, the most remarkable example of limited geographical distribution in the group. The Honey-scented Eucalypt (*E. melliodora*) is what is called, among such giants, a middle-sized tree, exceptionally attaining a height of some 200 feet; it will live on poor soil. In an official report presented in 1869 to the Victorian Parliament, Dr. Mueller pointed out that one ton weight of its branches and leaves, if gathered fresh, would yield about 2 lb. 12 oz. of pure potash, and a much larger quantity of crude pearl-ash. Another species, known from its odour as the "peppermint tree" (*E. odorata*), would seem to be a great favourite with a destructive nocturnal cockchafer. Through the immense clearings effected for agricultural settlements, the number of insect-eating birds has greatly diminished, and the increase of this species of Melolontha is not properly kept in check. They prey on the foliage of this Eucalypt, and Mr. Otto Tepper, writing in the *Transactions* of the Philosophical Society of Adelaide (February, 1878), states that it is being extensively destroyed from this fact.

The plates accompanying the descriptions of the species published in these decades give ample details of the leaves, flowers, and fruits of the species; they appear, so far as the stems with inflorescences are concerned, to be perhaps a little too stiff and formal. Sometimes details of the peculiar wood structures are added, and on one special plate transverse sections of the anthers of some fifty-eight species are figured. The London agents for this work are Messrs. Trübner and Co.

OUR BOOK SHELF

A Short Geography of the British Islands. By John Richard Green, M.A., LL.D., and Alice Stopford Green. (London: Macmillan and Co., 1879.)

"GEOGRAPHY, as its name implies, is an 'earth-picturing,' a presentment of earth, or a portion of earth's surface in its actual form, and an indication of the influences which that form has exerted on human history or human society. To give such a picture as this of our own country, in however short and simple a fashion, is the aim of the present work." Mr. and Mrs. Green have carried out the task they have here indicated in a masterly manner. The method they have adopted is the only scientific method on which a text-book of geography of this class can be constructed. Mr. Green, in his preface, speaks with just horror of the majority of text-books, with their dreary array of tables and "facts" and figures, which makes what ought to be one of the most interesting of lessons a burdensome and unprofitable penance.

In the first seven chapters the authors give a clear, instructive, and completely interesting sketch of the great physical features of our islands, and of their relation to the continent of Europe. The mountain groups, the uplands, the plains, and the rivers are brought before the student in their natural or scientific aspect, with just such details easily worked in as will give a clear picture of the various features. The counties are then grouped in their natural order, and each is treated after the same method as that followed in the general sketch. The great physical features are brought out first of all, the regions of the chief natural resources of the country indicated, and thus the mind of the pupil is prepared to understand how the political, social, and industrial features have come to be developed as we find them at the present day. "Facts" enough to satisfy any humane examiner are given, and the principal data and figures are collected in a few well-arranged tables. Great care has evidently been taken to obtain accurate and recent information both with regard to physical geography and topographical, industrial, and other statistics. Besides four coloured maps, there are twenty-four special sectional maps appropriately introduced throughout the book, which must prove of great use in impressing the facts upon the mind of the learner. We trust the Geography will be largely introduced into our schools; we are sure that the scholar at least would welcome it. Its style and method, moreover, render it attractive and instructive reading to those who have long left the school of their childhood behind.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Visibility of Mercury to the Naked Eye

IN NATURE, vol. xxi. p. 474, I find the following: "Mercury was seen at Paris on May (meant for March) 10 and 11 with the naked eye, owing to the transparency of the atmosphere and the great elongation of the planet. . . . The observation was made by MM. Henry brothers at the Paris Observatory."

Must not "the transparency of the atmosphere" have more to do with the visibility of this planet than is usually supposed? The leading circumstances affecting the question, the amount of the planet's elongation, the inclination of the ecliptic in which it is situated to the horizon, heliocentric latitude, &c., being of course the same at each apparition in England, on the Continent, and in North America, how shall we otherwise account for some of the facts of the case? The remark is current respecting Copernicus that he never obtained a view of Mercury. And perhaps the general impression as to its visibility—that it can be seen only at the most favourable junctures, and for but a few days at a time—is reflected in the quotation above.

As a contribution to the question as it may be affected by the variable element of *climate, atmosphere*, I tabulate herewith the results of several years' careful though not thoroughly systematic observation of the planet at this geographical position, latitude 44° 53′ N., longitude 93° 05′ W., elevation 800 feet above sea-level:—

Year.	Time observed.	Days.	G. Elong.	Date.
			° ′	
1877	... April 29 to May 11	... 13	... 21 5	... May 3
1878	... Sept.–Oct.	... —	... 17 53	... Sept. 26
1879	... Jan. 7 to Jan. 29	... 22	... 24 03	... Jan. 16
1880	... Feb. 29 to March 19	... 20	... 18 22	... March 10

It will be observed from the table that I followed Mercury with the naked eye at its last appearance in the west (when it was seen in Paris), from February 29 to March 19. I had intended to look for it a day sooner, February 28, as a crucial test as to how early it could be seen at that apparition, for it came into conjunction with Jupiter that day and would be approximately pointed out by the latter planet. But the state of the sky would not permit. Looking for Jupiter the next evening, so as to take bearings from him, I saw Mercury first, over a degree to the north-east of where Jupiter was when found. So I am confident that Mercury was within reach of the naked

eye the evening before at conjunction, save that clouds intervened. And this one day added to the twenty days actually recorded would make the period of visibility on this occasion three full weeks.

At the brightest the planet was fully equal to a 1st magnitude star, and for more than a week as bright as α Arietis, two hours to the east of it, with which I frequently compared it. It was brighter than Saturn (also in the twilight) for several evenings, and was seen casually, as any other star would be seen, as I came up town from business, for more than a week. As a friend of mine remarked, "it could be seen with half an eye."

As regards the earlier observations of the table, it will be noted that the planet was seen for thirteen days in the spring of 1877, though first looked for only five days before it reached its greatest eastern elongation. It was again beautifully seen several mornings near the close of September, 1878, coming twice into conjunction with Venus during that time, though the observations were not continued so as to try how long it could be followed.

Finally, in January, 1879, though the position of the ecliptic was not favourable, an elongation of over 24° and splendid skies enabled me to follow Mercury for twenty-two days in succession, or while he made a full one-fourth of a revolution round the sun!

If any interest attaches to this communication it will surely not be from a superfluous attempt to show that Mercury at special times becomes visible to the naked eye; but rather from its giving certain definite facts as to the exact *length of time* the planet has been observed, at the several apparitions indicated. The astronomical conditions of these returns of the planet may be made out with the help of an ephemeris and a celestial globe. I need only add that the observations were made in a climate where hours favourable for astronomical work may frequently be numbered by the hundred monthly, and own that the conditions of sky and atmosphere under which they were made were generally favourable to the best results. T. D. SIMONTON

St. Paul, Minnesota, U.S.A., May 1

Specialised and United Palæontological Research

In your report of Prof. Huxley's lecture on "The Coming of Age of the Origin of Species" there was one sentence which was pregnant with import to every true devotee of natural history and to every believer in the doctrine of evolution, to wit, that "primary and direct evidence in favour of evolution can be furnished only by palæontology."

Knowing that this is so, I ask, Do there exist amongst all our scientific associations delegated committees whose function it is to watch and foster palæontological research by every possible means? Seeing that so much depends on this kind of evidence, it is surprising that we hear so little of the results of any united efforts in this direction. What we generally hear of are the outcome mostly of private and individual inquiry. And since so much has already been done in this field of investigation by mere individual effort that the "missing links" between widely separated groups of the higher mammalia (not including man) have been discovered so abundantly that it can be said with respect to these, in the words of Prof. Huxley, "Evolution is no longer a speculation, but a statement of historical fact"—since this is the result of private and individual effort, what might not be achieved by united and organised research!

It is a truism that division of labour is the best means of specialising and perfecting any work, and an equally trite saying, that "union is strength;" yet in this, one of the most important of all the fields of biological study, we do not hear of a palæontological society or committee.

What could such a society or committee effect? it may be asked. Would it be expected to take hammer, pickaxe and spade in hand and wander over the wide world in exploration? Certainly not. But remaining at home, it could direct the efforts of private explorers, delegate officers of its own, equipped with the means of questioning the geological record in different parts of the globe, unite with kindred associations in solving problems too arduous for the single resources of one society, dividing alike the expenses and the spoil. Surely it would gratify the heart of every naturalist to learn if palæontological research had assumed this serious and energetic form.

How many opportunities are allowed to slip that might be turned to excellent account! Wars are carried on in countries as yet geologically unexplored, and for want of such a society as I have named there has been no one employed to accompany our armies in the cause of this branch of science. Railways and other engineering works have been carried out in such regions, but no one has been employed to watch the operations in the name of palæontology. Travellers go and return without having been furnished with data to guide researches that might have been intelligently prosecuted in the cause of science.

Will not our leaders in natural science arouse themselves to organised and specialised research in this all-important field of palæontology? W. S. DUNCAN

Stafford, May 29

The Meteorology of South Australia

[We have been asked to publish the following correspondence on an article on this subject in NATURE, vol. xxi. p. 281.]

South Australia, the Treasury, Adelaide,
April 15, 1880

SIR,—I have to thank you for the extract from NATURE, inclosed in your despatch No. 7,842, dated January 31 last, which was duly referred to the Honorable the Minister of Education, and has been perused by the Postmaster-General, &c., and observer, Mr. Todd, C.M.G., a copy of whose observations and remarks upon this subject I now forward for your information and that of the Editor of NATURE. I am, sir, your obedient servant, (Signed) C. MANN

Sir Arthur Blyth, K.C.M.G., Agent-General for
South Australia, London

Post and Telegraph Department

Memo. on Letter from Agent-General

METEOROLOGICAL OBSERVATIONS

The writer of the article in NATURE had evidently not received the volume for 1878, but only the monthly numbers. In the volume, as the Agent-General, to whom I have sent a copy, will see, I have given the results of the observations at Port Darwin, Alice Springs, Eucla, Cape Borda, Mount Gambier, and Cape Northumberland. As the Minister is aware, I have recommended that instruments should be supplied to several additional places, which will really give effect to what the writer in NATURE very properly urges. The extent and form in which the observations made at our institutions should be published require consideration on the score of economy of printing; and, as the Minister is aware, the observatory is altogether undermanned for the work now done, and if it were not for my own personal exertions in doing that which might be intrusted to assistants, we could not do what is done. With regard to the other suggestion, I had previously decided on correlating the rainfall and wheat-yield in different districts, in addition to the table, which takes the colony as a whole, now given.

The form in which our observations are published and discussed appears to give general satisfaction, and this will be greatly increased when we have the continuous self-recording instruments I have recommended should be obtained.

April 4 (Signed) C. TODD
P. M. G. and Supt. T.

[Mr. Todd is correct in supposing that the volume for 1878 was not before us—not having been then received—in writing the article on the "Meteorology of South Australia" in NATURE, vol. xxi. p. 281, but only the monthly numbers. The volume has, however, been received quite recently, which, in view of the highly important additions it contains, referred to by Mr. Todd, we shall take an early opportunity of noticing. It gives us the highest satisfaction to learn that of the two points we drew attention to half a year ago, the one relating to the establishment of additional stations had not only been resolved on, but actually carried out in the beginning of 1878, and as regards the other one, referring to the correlating of the rainfall and the wheat-yield in different districts, in addition to the table which deals with the colony as a whole, it had previously been decided by Mr. Todd to discuss the data in the manner suggested.—ED.]

Comparative Curves in Terrestrial Magnetism

As the comparison of curves obtained at distant stations is at present one of the most important desiderata for the study of terrestrial magnetism, I forward to you traces of two photographs obtained on March 17 last at Vienna and at Stonyhurst. The storm is a remarkable one, and the curves offer a striking illustration of the simultaneous action of the disturbing force on

two magnets many miles apart. The action of the force appears to have been somewhat more vigorous at Stonyhurst than at Vienna, yet not only the great inflections, but even the slight irregularities of the curves were synchronous.

The trace of the Vienna magnetograph is taken from the May number of the *Zeitschrift der österreichischen Gesellschaft für Meteorologie*, kindly forwarded by Dr. Hann.

The range between the maximum and primary minimum at 5h. 45m. p.m. G.M.T. was 33'·7 at Vienna, and 42'·1 at Stonyhurst; and between the same maximum and the secondary minimum at 10h. 45m. p.m. was 24'·1 at Vienna, and 34'·0 at Stonyhurst.

Both the self-recording magnetographs were made by Adie, and the time-scale is the same for both curves; it is therefore very easy to identify the synchronous movements.

At Stonyhurst G.M.T. is adopted, and the longitude of Vienna is 1h. 5m. 31·3s. E. of Greenwich. S. J. PERRY

Stonyhurst Observatory, May 27

Luminous Painting

Nil novi sub sole.—The Japanese, nine hundred years ago, seem to have been practically acquainted with the art of luminous painting, and thus to have anticipated Mr. Balmain. In looking through the article "ye" (pictures) in the Sinico-Japanese Encyclopædia, "Wakan san sai dzu-ye" (illustrated Description of the Three Powers, *i.e.*, Heaven, Earth, and Man), I recently came upon a passage, of which the following slightly condensed rendering may perhaps be of some interest to your readers:—

"In the Rui-yen (Lei-yuen, Garden of Sundries—a sort of Chinese Collectanea) we read of one Sü Ngoh, who had a picture of an ox. Every day the ox left the picture-frame to graze, and returned to sleep within it at night. This picture came into the possession of the Emperor T'ai Tsung, of the Sung dynasty (A.D. 976–998), who showed it to his courtiers, and asked them for an explanation, which none of them, however, could give. At last a certain Buddhist priest said that the Japanese found some nacreous substance within the flesh of a kind of oyster they picked up when the rocks were bared at low tide, and that they ground this into colour-material, and then painted pictures with it which were invisible by day and luminous by night."

"No doubt," adds the author of the Encyclopædia, "when it is said that the ox left the picture-frame during the day to go a-grazing, it is meant simply that during the day the figure of the ox was not visible." FREDK. V. DICKINS

Arts Club, June 1

Brain Dynamics

THERE are probably among the readers of NATURE some believers in the Freedom of Volition, to whom the discussion on the above subject has not hitherto appeared to reach the knottiest point of the controversy.

The more old-fashioned supporters of the doctrine of Free Will frequently insisted on the sense of Responsibility as the crucial proof that the will is free, probably because few of their opponents were ready to face the possible, or supposed, moral consequences of the denial of responsibility. The proof is essentially weak, and Mr. Romanes has well exhibited its weakness in NATURE, vol. xxii. p. 76. His "Prince of Denmark" has indeed so little of method in his madness that I am not disposed to think it curious that both Prof. Clifford and Mr. Tolver Preston should have left him out of their play. He may well exclaim: "What should such fellows as I do, crawling between earth and heaven? We are arrant knaves all; believe none of us." Surely the sense of Responsibility is not the origin, but is one of the results of the Sense of Freedom. Logically the Sense of Freedom is the justification of the sense of responsibility. Historically it is, no doubt, its antecedent; for while both are, as much as any other faculties of brute and man, results of evolution, the refinement of the conception of morality, and therefore probably the conception itself, has evidently originated long after the consciousness of volition. Experimentally the sense of responsibility is weakened or destroyed, either psychologically, as where the freedom of the actor is controlled, or physiologically, as where volition is suspended in sleep, or is impaired by lesion of the anterior lobes of the brain, in all which cases the sense of responsibility suffers corresponding loss. It seems to me strange that Mr. Romanes should suppose the doctrine of Free Will to have been conceived and continued in order to justify that Moral Sense which is essentially a consequence of it (though capable finally of being presented as one among other motives in certain acts of volition). It lies with those who think with Mr. Romanes to account, on their own hypothesis, for the development of so universal, obtrusive, irrational, and indeed "nonsensical" an instinct as, according to that hypothesis, the sense of responsibility is. Others will see in it a result of the Sense of Freedom of Volition, when combined with the intellectual perception of the consequences, to the individual or to the race, of human acts (the latter perception being the cumulative result of inherited experiences). This Sense of Freedom of Volition is the real Hamlet.

We possess, or appear to ourselves to possess, the consciousness of the power of choosing between alternative motives. It is unsafe merely to give the lie direct to this consciousness, lest we thereby destroy the validity of the evidence, also derived through consciousness, of all those facts on which any law of nature, and Causal Sequence itself, is based. The consciousness of power is derived from the sense of work done, as against resistance, *e.g.*, the consciousness of muscular power is derived from a class of sensations produced on the organism by resistance, these sensations being created by, and consequently associated with, the conversion of potential energy stored up in the brain into kinetic energy transmitted through the nerves and muscles, and it bears no psychological resemblance to the consciousness of sensations of which the brain is the passive recipient. Similarly, the consciousness of the power of volition is derived from the sense of work done, in this case wholly within the brain, in the selection between alternative motives, and it bears no psychological resemblance to the consciousness of the motives themselves. And so, too, just as the sense of lassitude is produced by excess of work done as against physical resistance, so is a sense of discomfort produced by expenditure of potential energy, when acts of volition are performed against powerful emotions.

It appears to me that the Necessitarian should be able on his part to show that this *sense of work performed in choosing between motives* is fictitious, or that the energy above mentioned has no existence. This will not be done solely by holding even the terrors of omnipotent Causal Sequence over the head of the advocate of Free Will. The latter considers volitions to be, not indeed "uncaused" in the sense of occurring without antecedent emotions, or without expenditure of energy in choosing between the emotions, yet not to be rigidly determined by those emotions. He need not inquire whether a man be "unfortunate" in the capricious character of human acts as compared with other phenomena. But he on his part has to show (and certainly no scientific mind will underrate the magnitude of the task) that phenomena of volition do, paradoxical as it may seem, constitute a class by themselves, their relation to physical causation being perhaps comparable to that in which the phenomena of life stand to the laws of inorganic chemistry, a relation of addition, not of contradiction. W. CLEMENT LEY

I SHOULD like to state, in reply to Mr. George Romanes' letter (NATURE, vol. xxii. p. 75), that the question of "Responsibility" was left out of my letter (NATURE, vol. xxii. p. 29) partly because it seemed to me a separate or somewhat distinct subject, and partly from the fact that this matter had been already considered by me in connection with a paper on "Natural Science and Morality," to be published in the *Journal of Science* for July next; and to this, therefore, I would venture to refer those who may be interested in this question.

I may merely conclude by saying that, while otherwise fully endorsing Mr. Romanes' letter, there is only one point on which I should be disposed to disagree with him, viz., in regard to his suggested view that the doctrine of strict causal sequence in nature would tend to show the feelings of Responsibility, Praise, and Blame to be "destitute of any rational justification." For there appear to me to be grounds for believing that a scientific and rational explanation of these feelings exists.

London, June S. TOLVER PRESTON

Vortex Atoms

WHILE thanking Mr. G. H. Darwin for his observations on one or two passages in my paper "On the Physical Aspects of the Vortex-Atom Theory," which, as they stand, may no doubt tend to convey an inexact impression, I may state that the illus-

tration of a pipe was used with the endeavour to aid the conceptions in some respects, rather than for rigid accuracy of comparison. The idea of the exterior fluid being *at rest* was subsequently guarded against by stating that it had "important functions" to perform. In regard to the fact of only mentioning "friction" as an element of resistance in a totally immersed body, I wished rather to convey the general idea that if no *energy* were given to the molecules of the surrounding liquid at the passage of the immersed body, there would be no "resistance." The object of the article was, however, not so much to lay stress on these points as to notice certain, perhaps less appreciated (*à priori*), aspects of the problem.

S. TOLVER PRESTON

Songs of Birds

YOUR correspondent "A. N." (*antè*, p. 97) does not seem to be aware that the best observers are nowadays agreed in believing that the hen cuckoo does not sing. Hence his suggestion in regard to the difference of note observed by Mr. Birmingham (*antè*, p. 76) hardly applies to the case in question.

ALFRED NEWTON

Magdalene College, Cambridge, June 6

I HAVE been in the habit of observing the notes of cuckoos, and have noticed that the musical interval is very variable. It is not always, or even often, amenable to our tempered scale, but may lie anywhere between a major 2nd and a 4th. The major 3rd seems to be about as frequent as the minor. The interval may vary in the same bird, as it is well known that the cuckoo's song alters greatly with the approach of summer.

FRANK J. ALLEN

St. John's College, Cambridge, June 6

Cup-marked Stones

ON a large block of fine-grained hard whitish sandstone near Burghead, Elgin, are forty-four cup-marks of various sizes, but all very finely formed. Four of the cups have channels or grooves of various lengths and running in different directions, but none to the edge of the stone. Five have one ring, and channels of various lengths, and in different directions. Four have got two rings and channels, and one has three rings and a channel. In some cases the rings are not complete, that is, they stop short on either side of the channel, but close to it. One cup has a simple ring.

From this example, and if I recollect the figures in Sir J. Y. Simpson's work, there seems to be but few cases in which the channels run to the edge of the stone.

Out of a considerable number of cup-marked stones partly on finely ice-polished rock surfaces and partly on detached blocks large and small, in Elginshire, this is the only one that has rings and grooves. A full description of these, with plans, I have nearly ready to lay before the Society of Antiquaries at one of their early meetings of next session.

JAMES LINN

Keith, June 2

THE DUMAS NUMBER.—In reply to numerous inquiries we may state that the portrait of M. Dumas should form the frontispiece to vol. xxi., and the article by Dr. Hofmann be placed after the index in the beginning of the volume.

ENERGY AND FORCE[1]

[ON March 28, 1873, Clifford delivered a Friday evening discourse on this subject at the Royal Institution. By some accident no trace of it, not even the date or title, appears in the printed *Proceedings*. Thus the lecture escaped notice when Clifford's literary and scientific remains were collected in the summer of last year. A few weeks ago I lighted on my own rough notes of it taken down at the time, probably the only record now in existence. These I have written out, with only so much alteration and addition (indicated by square brackets) as necessary to make them intelligible. The paper thus produced has been seen by Clifford's friend and mine, Mr. J. F. Moulton, who (besides his general competence in mathematical physics) was thoroughly acquainted with Clifford's mathematical work and ideas. Mr. Moulton has added, by way of introduction, some remarks founded on this intimate knowledge, which will explain the aims of the discourse and supplement the too meagre report which is all that I am able to reconstruct from my notes.—F. POLLOCK.]

This lecture was, I think, written as a protest against certain loose ideas that had become prevalent relating to energy, motion, and force. The discoveries as to the equivalence of the many forms of energy and the invariability of the total of energy in any system not operated on by external forces (one case of which is the whole material universe), had led philosophical writers and others to treat force as an entity with a separate existence like matter, and also, like it, indestructible. The error of thus treating force as an entity with a separate existence was not an unnatural one in those who had not much acquaintance with the theories of physics. No idea is more consonant with the ordinary modes of thought than that force is a something operating from without on a body, and producing effects thereupon in the shape of an alteration of its motion, so that the quasi-personification of force contained in the above does not appear to be in any way an unwarranted conception. The further step, which ascribes to force an indestructibility as absolute as that of matter, is due to a confusion in the terms used by mathematicians themselves in speaking of these subjects, for which they are to blame. Before the conservation of energy was fully formulated, mathematicians were acquainted with a particular case of the general principle, and it had received the name of conservation of force. This unfortunate appellation, with all its misleading tendencies, was often applied to the general principle when the latter first became known, and hence unscientific writers naturally assumed that force and energy were convertible terms and that they were alike indestructible. These erroneous conceptions had attracted Prof. Clifford's attention, and with his usual zeal for preserving scientific ideas from all taint, he set about correcting them. His mode of doing so is highly characteristic. He strikes straight at the root of the matter, and would have us at once cease to think of force as an entity at all. Indeed he goes so far as almost to warn us against tolerating the conception of a cause as distinguished from its effects.

All we know as to force and motion, he says, is that a certain arrangement of surrounding bodies produces a certain alteration in the motion of a body. It has been usual to say that this arrangement of surrounding bodies produces a certain force, and that it is the action of this force that produces the alteration of the motion. Why have this intermediate term at all? Why should we not go at once from the surrounding circumstances to the alteration of motion which follows? The intermediate term is only a mental inference either from the existence of the surrounding circumstances or from the occurrence of the alteration in the motion; and if we only accustom ourselves to pass from one to the other without its assistance, it will cease to be necessary, and like other useless mental conceptions, be gradually forgotten. And with it will pass all tendency to give to this useless mental phantom any such real and material qualities as indestructibility.

I was not present when the lecture was given, nor do I know otherwise than from these notes how Prof. Clifford carried out these ideas. But in conversation he had often discussed the matter with me, and made me fully acquainted with his views on the subject, so that I am able thus far to confirm the accuracy and completeness of these notes. It will be seen that he defines force as

[1] An unpublished discourse by the late Prof. Clifford. With an introductory note by J. F. Moulton.

"the change of momentum of a body considered as depending upon its position relative to other bodies," thus bringing into direct connection the surrounding bodies and the consequent alteration of motion and rendering the conception of force a superfluous one. In his concluding remarks as to whether we are directly conscious of force, there is the same tendency. He is well aware that such an attempt as his will be viewed with very little favour by the not unimportant school of philosophers who conceive that force is the only thing that we are directly conscious of, and thus he takes the opportunity to combat this idea.

The part of the lecture that refers to energy needs no special remark. He shows, in his usual clear style, at once how much and how little is contained in the law of the conservation of energy. So far from containing in itself the solution of all the changes in the universe, it tells us only one of the conditions that these must obey, and gives us very little information, if any, as to the particular results that follow from the causes that are at work. It is invaluable as a negative law. It enables us to reject with absolute certainty countless hypotheses that would otherwise be temptingly appropriate to elucidate the complexities of nature. But further than that it cannot go. It cannot distinguish between the innumerable hypotheses that satisfy it, of which, after all, only one can be true. J. F. M.

No mathematician can give any meaning to the language about matter, force, inertia, used in current text-books of mechanics.

The old definition of *force* contains the word cause. In the older writers this is a mere manner of speaking; thus Maclaurin defines velocity as the cause of a body changing its position. We now define it as the rate of change of position.

Causation is defined by some modern philosophers as unconditional uniformity of succession, *e.g.*, existence of fire follows from putting a lighted match to the fuel.

This idea must be got rid of to understand force. All universally true laws of nature are laws of co-existence, not succession. Thus, I want to move a thing and I push it, and motion follows. This suggests at first sight the conception of cause and effect being related in succession. But really you change the rate of motion of a thing *at the time* when you push it, not afterwards. So if you drop a thing from your hand, the letting go and the falling down are really simultaneous. Again, the change of motion of a terrestrial body is at every instant dependent on its distance from the earth's centre (though in practice this is neglected for small distances). In every case the law at work is seen to be a law of co-existence, not succession.

Momentum may be roughly described as quantity of motion. A body moving at a speed of say twenty miles an hour, has a certain quantity of motion. If the same body goes forty miles an hour there is twice as much motion; or if twice as much matter goes twenty miles an hour, there is also twice as much motion. Momentum is measured by the quantity of matter moving at a given rate (mass × velocity).

How is the quantity of matter measured if we compare bodies of different substances, such as wood and lead? Not by size: there is another scale by which the quantity of matter in a given body, without regard to the kind of matter, can be measured. [The existence of such a scale and the possibility of applying it are involved in the idea of *mass*.] The simplest method of applying that scale in practice is to weigh the two bodies to be compared at the same place.

Force cannot be explained without stating a law of nature concerning momentum, viz.:—

Suppose a body with a certain momentum to be the only body in the universe; it will go on with the same momentum.

If there is any change, there is another body, and the change depends on the position of that body.

The case of bodies in contact is no exception to this law, but only a particular case. Here the change of motion is called *pressure*. The case of bodies not in contact is illustrated by the motion of the earth about the sun [under the force of gravitation, as we call it].

In all cases change of motion is connected by invariable laws with the position of surrounding bodies. Force, then, has a definite direction [at every instant] at any point in space, and depends on the position of surrounding bodies, and may be described as the change of momentum of a body considered as depending upon its position relative to other things. It embodies the quality of direction as well as magnitude. In other words, it is a *quantity having direction*.

Force, defined as above, is not conserved at all. It may appear and disappear; it is continually being created and destroyed. "Conservation of force" is, mathematically speaking, a contradiction in terms.

Energy [is of two kinds: 1. Energy of motion; 2. Energy of position].

1. In a moving body we have a certain *quantity of motion* [as explained above under the head of momentum]. Thus in a moving railway train let the unit of motion be one carriage going at the rate of one mile per hour; then ten carriages going at the rate of twenty miles per hour have 200 units of motion. [The quantity of motion or momentum in a body may be regarded as travelling with the body, and] energy of motion is the *rate at which momentum is carried along*. [It depends on momentum and velocity jointly, and the energy of motion of a given body] is known when the velocity is known. In practice it is convenient to call the actual amount of energy of motion half this rate. It is expressed by $\frac{1}{2} m v^2$ [*i.e.*, $m v \times v$, not $m \times v^2$: Clifford, in conversation].

2. Energy of position is quite a different thing. If I take a book lying on the table and lift it up, and put it on the desk above the table, it acquires energy of position, and the energy acquired is measured by the weight [assuming gravity to be constant] of the book multiplied by the difference of height between the two positions. [Energy of position, like force, may be said to exist at any point of space, whether a body is there or not.] The difference of energy between two positions is the quantity of work that must be done to remove a body of unit mass from one position to the other.

When a body is let fall from a higher position to a lower one, it has, at the instant when it is let go, no energy of motion; but it gains, in falling, as much energy of motion as it loses energy of position. It is found that the *sum of energy of motion and energy of position is always constant.*

Force, we have seen, is a quantity which has direction. Energy is a quantity which can be greater or less, but has no direction. The name Energy is applied to two different quantities, of which we find the sum to be constant. This constancy is expressed by including them in the common name of Energy, and saying that energy is conserved, or is indestructible. This form of speech might be applied to other cases of alternate immortality, where one of two things comes into existence on the disappearance of the other.

Does the law of persistence of energy mean no more than this? Yes, [it means more when it is used to include the "correlation of physical forces]". Other qualities of bodies are connected with simple energy of motion and energy of position. Such is heat, which we find by experiment can be turned into work. Finding it convertible with energy, we call it a form of energy.

Here we have [it seems] three different things included: energy of motion, energy of position, heat. But as to

heat, it is further established by experiment that in this case the energy of motion does really persist as such. Thus a gas consists of molecules flying about with great velocity, rotating and vibrating, and so having energy of motion. All this energy of motion is what we call heat, and thus heat is a repetition of a known meaning of energy. Again, heat exists between a radiating body and the thing it warms; now the intermediate space is filled by the luminiferous ether, which, being elastic, has in its ultimate parts both energy of motion and energy of position. In these forms the heat exists in the space in question.

In the cases of heat and electricity the form of the persisting energy is pretty well ascertained. But there are cases in which we do not know if it is energy of motion or energy of position, such as that of *chemical energy*. In the burning of coal there is a falling together of carbon and oxygen [and heat is produced]; but we do not know in which of the two forms, if either, the energy which comes out as heat existed in the chemical process. For such a case the conservation of energy is only a probable statement (though of great probability) to the effect that in all cases where a physical quality is convertible with energy, that quality is itself either energy of motion or energy of position.

General Results.—Force is a quality of position, definite in magnitude and direction at any point; not constant.

Energy is the name of two different quantities.

1. Energy of motion, half the rate at which a body carries momentum.

2. Energy of position, defined by the statement of the law that the work done in getting from one position to another is the same by whatever path the change of position is made.

[The definition of these conceptions helps to clear up sundry questions of mixed physics and metaphysics.]

1. Is a physical force, such as the attraction of the earth, analogous to our "exertion of force" in muscular work? No, for the sensation of muscular effort is very complicated. It involves nerve and muscle, which we know not to be present in the simpler cases, *e.g.*, the motion of a stone let fall. To talk of *pushing* or *pulling* in such a case is a personification of external nature.

2. Are we directly conscious of force? It is often said in physical and metaphysical works that we are. It may be true, but it is at least premature. We do not *know* that the chemical changes in nerve-matter corresponding to consciousness are energy [only that they are *convertible with* dynamical energy]; much less do we know that they are force. If they are energy, it is energy of motion, not energy of position, since consciousness does not depend on the position of the nerve-matter [so my notes: *sed quære*].

3. Is mind a force? It is held by some that the will acts as the match to gunpowder, by setting loose a store of energy, the matter of the brain being in unstable equilibrium. But you cannot have in nature an absolutely unstable equilibrium [*i.e.*, an equilibrium capable of being upset by an infinitesimal force], because the universe is not at rest [and every motion in the universe produces a finite change, however small, in the resultant force at every point of space]. Therefore if mind is force, operating in the way suggested, it must be able to create a determinate quantity of energy. This is a supposition which, if true, would destroy its own evidence; for it would destroy the uniformity of nature, on which all possibility of inference ultimately rests.

[The discourse concluded by pointing out that even from a purely scientific point of view, metaphysical speculation is to be encouraged as a spur to science.]

ECHIS CARINATA

THOSE who are interested in the poisonous snakes of India may have an opportunity of seeing one of the most interesting and destructive of these reptiles, now in the Zoological Society's Gardens in Regent's Park.

The snake I refer to is a fine specimen of the *Echis carinata*, which has recently arrived from India, and is the first of its kind, I am told, that has been received alive in this collection. I think it is probable, however, that a snake so common in some parts of India must have been brought alive to England before; but at any rate it is rare, and sufficiently interesting to claim attention, especially as it is healthy, vigorous, and active, and readily shows its peculiar habits, in the attitude it assumes and the rustling sound it gives rise to by the friction of the carinated scales of one fold of its body against those of the other when alarmed, and in the aggressive position which it takes up when prepared to strike, which it does most viciously by launching out its head and the anterior part of its body from the centre of the convoluted folds into which it has arranged itself. There are, I believe, only two true vipers in India (though there are several Crotalidæ), the *Daboia russellii*, or chain viper, or ticpolonga, and the *Echis carinata*. The daboia is well known here, and there are, or have been lately, fine specimens in the Society's collection; but the echis is not so well known, though common enough in India.

It is much smaller than the Daboia, and is very active and dangerous. It is known in Sind as the "kuppur"; in other parts of the country as "phoorsa"; about Delhi it is "afäe," or "afai" (a word of Arabic origin). Russell calls it "horatta pam." It seldom attains more than the length of 20 to 22 or 23 inches; probably 15 or 16 inches is more common, and is from 2 to 2½ or 3 inches in circumference at the thickest part of the body.

It is very fierce and aggressive, always ready to attack. It throws itself into a double coil, the folds of which are in perpetual motion; the whole body does not necessarily change its place, and as they rub against each other they make a loud rustling sound, which may be mistaken for hissing. This is produced by the three or four outer rows of carinated scales, which are prominent and point downwards at a different angle to the rest; their friction against each other causes the loud rustling sound which gives notice of the presence of the echis, as does the rattle of the crotalus.

I have never heard this viper hiss; though the daboia does so loudly. It is of a brownish-grey colour, with white and dark spots, and a waving whitish band on either side of the body. On the head there is a peculiar mark something like a cross. Its fangs are very long and mobile, and its poison very active, destroying a fowl in two or three minutes. In Sind, and some other parts of India where it is very common, it causes considerable loss of human life, though I believe it is not so destructive on the whole as either the cobra or *Bungarus cæruleus* (Krait), which are more generally distributed over the peninsula. I have not seen it in Bengal, but it is common in the North-West Provinces, Punjab, Sind, and Central Provinces, and Southern India in the Carnatic, and about Madras.

Its aggressive aspect when roused, the vicious eye, its peculiar method of folding itself, the rustling of its scales, and the rapidity with which it strikes, make it, when living, an object of considerable interest.

In the same collection there is a fine specimen of another very rare colubrine venous snake, the *Ophiophagus elaps*, which gives an opportunity not often available even in India, where the snake is found only in certain localities, of studying its peculiar habits and food, which consists of other snakes. It is as deadly as the cobra, to which it is nearly allied; but from its comparative rarity and the nature of its habitat it does not contribute so largely to the death-rate as that snake or even as the little echis.

J. FAYRER

CONTRIBUTIONS TO MOLECULAR PHYSICS IN HIGH VACUA[1]

II.

IT has been shown that the stream of molecules are shot off from the negative pole in a negatively charged condition, and their velocity is owing to the mutual repulsion between the similarly electrified pole and molecules. It became of interest to ascertain whether lateral repulsion was exerted between the molecules themselves. If the stream of molecules coming from the negative pole carried an electric current, two parallel rays should exert mutual attraction; but if nothing of the nature of an electric current was carried by the stream, it was likely that the two parallel rays would act simply as negatively electrified bodies and exert lateral repulsion. This was not difficult to put to the test of experiment.

A tube was made with two flat aluminium terminals, *a b*, close together at one end, and one terminal, *c*, at the other, as shown in Fig. 11. Along the centre of the tube, cutting the axis obliquely, is a screen of mica, painted over with a phosphorescent powder, and between the screen and the double poles, *a b*, is a disk of mica crossing the axis of the tube, and therefore nearly at right angles to the phosphorescent screen. In this mica disk are two slits—one opposite each pole *a* and *b*—running in such a direction that the molecular streams emanating from *a* and *b* when made negative shall pass through the slits, forming two horizontal sheets. These sheets striking against the oblique screen will be made evident as two horizontal lines of light. The poles *a* and *b* were somewhat bent, so that the lines of light were not quite parallel, but slightly converged. The tube being properly exhausted, the pole *a* was made negative, and *c* positive, the lower pole *b* being left idle. A sharp ray of phosphorescent light shot across the screen along the line *d f*. The negative wire was now transferred from *a* to *b*, when a ray of light shot along the screen from *e* to *f*. The two poles *a* and *b* were now connected by a wire, and the two together were made the negative pole. Two lines of light now shone on the screen, but their positions, instead of being, as before, *d f* and *e f*, were now *d g* and *e h*, as shown by the dotted lines. The wire joining the poles *a b* was removed, and the pole *a* made negative; the ray from it followed the line *d f* as before. While the coil was working, another wire hanging loose from the pole *b* was brought up to *a*, so as to make them both negative. Instantly the ray *e h* shot across the screen, and simultaneously the ray *d f* shifted its position up to *d g*. The same phenomena were observed when the pole *b* was connected with the coil, and contact was alternately made and broken with *a*; as the ray *d g* shot across, the ray *e f* dipped to *e h*.

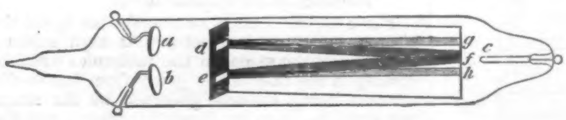


FIG. 11.

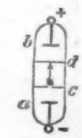


FIG. 12.

These experiments show that two parallel rays of molecules issuing from the negative pole exert lateral *repulsion*, acting like adjacent streams of similarly-electrified bodies. Had they carried an electric current they should have attracted each other, unless, indeed, the attraction in this case was not strong enough to overcome the repulsion.

Many experiments have been made to ascertain the law of the action of magnets and of wires carrying currents, on the stream of molecules.

As an indicator, a small tube, as shown in Fig. 12, was employed. The two poles are at *a* and *b*, *a* being the negative. At *c* is a plate of mica with a hole in its centre, and at *d* is a phosphorescent screen. A sharp image of the hole in the mica is projected on the centre of *d*, and the approach of a magnet causes this bright spot to move to different parts of the phosphorescent screen.

A large electro-magnet was used, actuated by two Grove's cells, and the indicator tube was carried round the magnet in different positions and the results noted. The molecular stream when under no magnetic influence passes along the axis of the tube, as shown by the small arrow (Fig. 12). It will be seen that the indicator can occupy three different directions in respect to the magnet. The magnet being held horizontally, the direction of the molecular stream may be parallel to the axis, tangential to it, or at right angles to it. In either of these positions, also, the stream may be directed one way or the other (by turning the tube round endwise). In these different positions various results are obtained which are easily illustrated with a solid model, but are somewhat complicated to explain by means of flat drawings. They are fully described in the paper.

A long tube was made similar to the small indicator shown in Fig. 12, but having a molecular trajectory six inches long. It was only exhausted to the point at which the image of the spot was just seen sharply defined on the screen, as at higher exhaustions the action of magnetism is less. The phosphorescent screen was divided into squares for convenience of noting the deflection of the spot of light. So sensitive was this to magnetic influence, that when the tube was placed parallel to the earth's equator the earth's magnetism was sufficient to cause the spot to move 5 millims. away from the position it occupied when parallel to the dipping needle (in which position the earth's magnetism did not appear to act). When held equatorially and rotated on its axis, the spot of light, being always driven in one direction independent of the rotation of the tube, appeared to travel round its normal position in a circle of 10 millims. diameter.

I have long tried to obtain continuous rotation of the molecular rays under magnetic influence, analogous to the well-known rotation obtained at lower exhaustions. Many circumstances had led me to think that such rotation could be effected. After many failures an apparatus was constructed as follows, which gave the desired results:—

A bulb (Fig. 13) was blown of German glass, and a smaller bulb was connected to each end of the larger bulb by an open, very short neck. At each extremity was a long aluminium pole projecting partly into the large bulb and turned conical at the end. After good exhaustion the passage of an induction current through this apparatus fills the centre bulb with a very fine green light, whilst the neck surrounding the pole which happens to be negative is covered with two or three dark and bright patches in constant motion, following each other round first one way and then the other, constantly changing direction and velocity, sometimes dividing into other patches, and at others fusing together into one. After a

[1] "Contributions to Molecular Physics in High Vacua. Magnetic Deflection of Molecular Trajectory; Laws of Magnetic Rotation in High and Low Vacua; Phosphorogenic Properties of Molecular Discharge." By William Crookes, F.R.S. (Extracts from a paper in the *Philosophical Transactions* of the Royal Society, Part 2, 1879.) Continued from p. 104.

little time, probably owing to the magnetism of the earth, or that of the core of the induction coil not far off, the movements sometimes become more regular, and slow rotation takes place. The patches of light concentrate into two or three, and the green light in the bulb gets more intense along two opposite lines joining the poles forming two faintly outlined patches, which slowly move

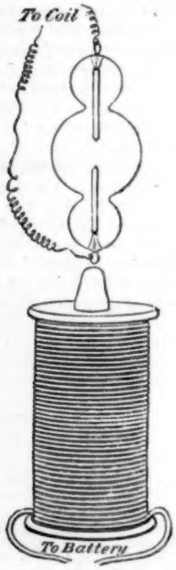


FIG. 13.

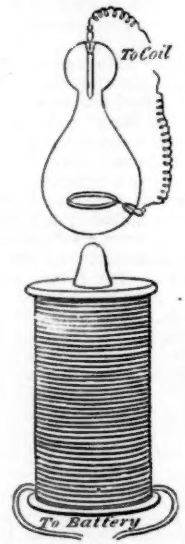


FIG. 14

round the bulb equatorially, following each other a semi-circumference apart.

An electro-magnet placed beneath in a line with the terminals (Fig. 13) converts these undecided movements into one of orderly rotation, which keeps up as long as the coil and magnet are at work.

In order to compare accurately the behaviour of the molecular streams at high exhaustions with that of the ordinary discharge through a moderately rarefied gas, another tube was taken having the upper pole an aluminium wire, and the lower one a ring, Fig. 14. It was only exhausted to such a point that the induction spark should pass freely from one pole to the other in the form of a luminous band of light, this being the form of discharge usually considered most sensitive to magnetic influence. This tube was also mounted over an electro-

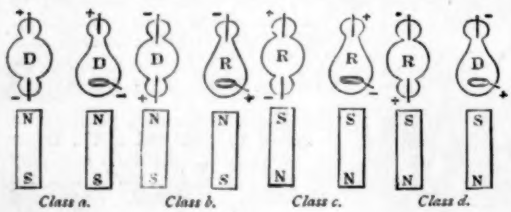


FIG. 15.

magnet, and the two sets of apparatus being actuated successively with the same coil and battery, the following observations were made.

The tubes will be distinguished by the terms "high vacuum" (Fig. 13) and "low vacuum" (Fig. 14). The rotation produced in each tube will be recorded in the direction in which it would be seen by an observer above, looking vertically down on the tube, his eye being in a line with the terminals and with the axis of the magnet. When the rotation thus viewed is in the direction of the hands of a watch, it is called *direct;* the opposite movement being called *reverse.* To facilitate a clear appreciation of the actions, an outline sketch (Fig. 15) accompanies each experiment. The shape of the tube shows whether it is the high or low vacuum tube, and the letter D or R shows the direction of rotation.

a. Upper pole of electro-magnets *north.*
Induction current passing through tubes so as to make the top electrode *positive.*
Rotation in the high vacuum *direct.*
Rotation in the low vacuum *direct.*

b. Upper pole of magnets *north.*
Top electrode of tubes *negative.*
Rotation in high vacuum *direct.*
Rotation in low vacuum *reverse.*

c. Upper pole of magnets *south.*
Top electrode of tubes *positive.*
Rotation in high vacuum *reverse.*
Rotation in low vacuum *reverse.*

d. Upper pole of magnet *south.*
Top electrode of tubes *negative.*
Rotation in high vacuum *reverse.*
Rotation in low vacuum *direct.*

These experiments show that the law is not the same at high as at low exhaustions. At high exhaustions the magnet acts the same on the molecules whether they are coming to the magnet or going from it, the direction of rotation being entirely governed by the magnetic pole presented to them, as shown in cases *a* and *b* where the north pole rotates the molecular stream in a *direct* sense, although in one case the top electrode is positive and in the other negative. Cases *c* and *d* are similar; here the magnetic pole being changed, the direction of rotation changes also. The direction of rotation impressed on the molecules by a magnetic pole is opposite to the direction of the electric current circulating round the magnet.

The magnetic rotations in low vacua are not only fainter than in high vacua, but they depend as much on the direction in which the induction spark passes through the rarefied atmosphere, as upon the pole of the magnet presented to it. The luminous discharge connecting the positive and negative electrode carries a current, and the rotation is governed by the mutual action of the magnet on the perfectly flexible conductor formed by the discharge.

In high vacua, however, the law is not the same, for in cases *b* and *d* similar arrangements produce opposite rotations in high and in low vacua. The deflection exerted by a magnet on the molecular stream in a high vacuum may be compared to the action of a strong wind alowing across the line of fire from a mitrailleuse. The deflection is independent of the to-and-fro direction of the bullets, and depends entirely upon the direction of the wind.

I have already mentioned that platinum will fuse in the focus of converging molecular rays projected from a concave pole. If a brush of very fine iridio-platinum wire, which has a much higher fusing point than platinum, be used to receive the molecular bombardment, a brilliant light is produced, which might perhaps be utilised.

A piece of apparatus was constructed in which a plate of German glass was held in the focus of the molecular bombardment. The vacuum was so good that no hydrogen or other lines could be seen in the spectrum of the emitted light. The focus was now allowed to play on the glass, when the glass soon became red hot. Gas appeared in the tube, and hydrogen lines now were visible in the spectrum. The gas was pumped out until hydrogen disappeared from the spectrum. It was now possible to heat the glass to dull redness without hydrogen coming in the tube; but as soon as the heat approached the fusing point

the characteristic lines appeared. It was found that however highly I heated the glass and then pumped the tube free from hydrogen, I had only to heat the glass to a still higher temperature to get a hydrogen spectrum in the tube. I consider the hydrogen comes from vapour of water, which is obstinately held in the superficial pores, and which is not entirely driven off by anything short of actual fusion of the glass. The bubbles noticed when the disintegrated and fused surface of the tube was examined under the microscope are probably caused by escaping vapour of water.

When the negative discharge has been playing for some time on German glass, so as to render it strongly phosphorescent, the intensity of glow gradually diminishes. Some of this decline is due to the beating of the glass or to some other temporary action, for the glass partially recovers its property after rest; some is due to a superficial change of the surface of the glass; but part of the diminished sensitiveness is due to the surface of the glass becoming coated with this brown stain.

The luminous image of a hole in a plate of mica was projected from a *platinum* plate used as a negative pole, to the side of a glass bulb. The coil was kept playing for some time until the inside of the bulb was thoroughly darkened by projected platinum. Although a bundle of molecular rays could be seen all the time passing from the platinum through the hole in the mica to the glass, where it shone with a bright green light, I could detect no trace of extra darkening when the part of the glass formerly occupied by the green spot was carefully examined. Platinum is a metal which flies off in a remarkable manner when it forms the negative pole. It therefore appears from this experiment that the molecular stream does not consist of particles of the negative pole shot off from it.

One of the most striking of the phenomena attending this research has been the remarkable power which the molecular rays in a high vacuum possess of causing phosphorescence in bodies on which they fall. Substances known to be phosphorescent under ordinary circumstances shine with great splendour when subjected to the negative discharge in a high vacuum. Thus, a preparation of sulphide of calcium, much used now in Paris for coating clock faces which remain luminous after dark, is invaluable in these researches for the preparation of phosphorescent screens whereon to trace the paths and trajectories of the molecules. It shines with a bright blue-violet light, and when on a surface of several square inches is sufficient to light up a room. Modifications of these phosphorescent sulphides shine with a yellow, orange, and green light.

The only body I have yet met with which surpasses the luminous sulphides both in brilliancy and variety of colour is the diamond. Most of these gems, whether cut or in the rough, when coming from the South African fields, phosphoresce of a brilliant light blue colour. Diamonds from other localities shine with different colours, such as bright blue, pale blue, apricot, red, yellowish-green, orange, and bright green. One beautiful green diamond in my collection when phosphorescing in a good vacuum gives almost as much light as a candle; the light is pale green—almost white. A beautiful collection of diamond crystals kindly lent me by Prof. Maskelyne phosphoresce with nearly all the colours of the rainbow, the different faces glowing with different shades of colour.

Next to the diamond, alumina in the form of ruby is perhaps the most strikingly phosphorescent stone I have examined. It glows with a rich, full red; and a remarkable feature is that it is of little consequence what degree of colour the earth or stone possesses naturally, the colour of the phosphorescence is nearly the same in all cases; chemically precipitated amorphous alumina, rubies of a pale reddish-yellow, and gems of the prized "pigeon's blood" colour, glowing alike in the vacuum, thus corroborating E. Becquerel's results on the action of light on alumina and its compounds in the phosphoroscope (*Annales de Chimie et de Physique*, sér. 3, vol. lvii.). Nothing can be more beautiful than the effect presented by a mass of rough rubies when the molecular discharge plays on them in a high vacuum. They glow as if they were red hot, and the illuminating effect is almost equal to that of the diamond under similar circumstances.

By the kindness of M. Ch. Feil, who has placed large masses of his artificial ruby crystals at my service, I have been enabled to compare the behaviour of the artificially formed crystals with that of the natural ruby. In the vacuum there is no difference whatever; the colour of the phosphorescence emitted by M. Feil's crystals is of just as an intense a colour, and quite as pure in character, as that given by the natural stone. This affords another proof, if one were needed, that Messrs. Fremy and Feil have actually succeeded in the artificial formation of the veritable ruby, and have not simply obtained crystals which imitate it in hardness and colour.

The appearance of the alumina glow in the spectroscope is remarkable. There is a faint continuous spectrum ending in the red somewhere near the line B; then a black space, and next an intensely brilliant and sharp red line to which nearly the whole of the intensity of the coloured glow is due. The wave-length of this red line, which appears characteristic of this form of alumina, is 689·5 m.m.m., as near as I can measure in my spectroscope; the maximum probable error being about $\pm$ ·3.

This line coincides with the one described by E. Becquerel as being the most brilliant of the lines in the spectrum of the light of alumina, in its various forms, when glowing in the phosphoroscope.

This coincidence affords a good proof of the identity of the phosphorescent light, whether the phosphorescence be produced by radiation, as in Becquerel's experiments, or by molecular impact in a high vacuum.

I have been favoured by my friend Prof. Maskelyne with the following notes of results obtained on submitting to the molecular discharge various crystals which he lent me for the purpose of these experiments:—

"Diamond crystals. A very small crystal, exhibiting large cube faces with the edges and angles truncated, was of a rich apricot colour, the dodecahedral faces of a clear yellow, and the octahedral of another yellow tint. No polarisation of the light was detected. Some were opaque; some gave a bluish hazy light.

"Emerald. A small hexagonal prism gave out a fine crimson-red colour. The light was polarised, apparently completely, in a plane perpendicular to the axis; this would correspond therefore to extraordinary rays which in emerald, as a negative crystal, represent the quicker rays vibrating presumably parallel to the optic axis of the crystal.

"Other emeralds behaved in the same way, though the illumination in two others experimented with appeared confined more particularly to one end—the end opposite to that at which the crystals presented some (in one instance fine) terminal faces.

"Beryls exhibited no corresponding phenomena.

"Sapphires gave out a bluish-grey light, distinctly polarised in a plane perpendicular to the axis. In this case, again, the ray developed corresponds to the extraordinary or quicker ray.

"Ruby gives out a transcendently fine crimson colour, exhibiting no marked distinction in the plane of its polarisation, though in one part of a stone the colour was extinguished by a Nicol prism with its long diagonal parallel to the axis of the crystal. Here, therefore, also the light was that of the extraordinary ray.

"It seemed desirable to determine the nature of the phenomena in the case of positive crystals, and accord-

ingly crystals of quartz, phenakite, tinstone, and hyacinth (zircon), were placed in a tube and experimented on.

"The only crystals that gave definite results were tintone and hyacinth. A small crystal of the former mineral glowed with a fine yellow light, which was extinguished almost entirely when the long diagonal of the Nicol was perpendicular to the axis of the crystal.

"Here, therefore, the plane of polarisation of the emitted light was parallel to the axis of the crystal, and here it is again the quicker, though in this case (of an optically positive crystal) it is the ordinary ray which corresponds to the light evoked by the electric stream.

"So far, then, the experiments accord with the quicker vibrations being called into play, and therefore in a negative crystal the extraordinary and in a positive crystal the ordinary is the ray evoked.

"A crystal of hyacinth, however, introduced a new phenomenon. In this optically positive crystal the ordinary ray was of a pale pink hue, the extraordinary of a very beautiful lavender-blue colour. In another crystal, like the former from Expailly, the ordinary ray was of a pale blue, the extraordinary of a deep violet. A large crystal from Ceylon gave the ordinary ray of a yellow colour, the extraordinary ray of a deep violet hue.

"Several other substances were experimented on, including some that are remarkable for optical properties, among which were tourmaline, andalusite, enstatite, minerals of the augite class, apatite, topaz, chrysoberyl, peridot, garnets of various kinds, and parisite. So far, however, these minerals have given no result, and it will be seen that the crystals which have thus far given out light in any remarkable degree are, besides diamond, uniaxal crystals (an anomaly not likely to be sustained by further experiment); and the only conclusion arrived at is, that the rays whose direction of vibration corresponds to the direction of maximum optical elasticity in the crystal are always originated where any light is given out. As yet, however, the induction on which so remarkable a principle is suggested cannot be considered sufficiently extended to justify that principle being accepted as other than probable." WILLIAM CROOKES

ON THE LAW OF FATIGUE IN THE WORK DONE BY MEN OR ANIMALS

THE Rev. Dr. Haughton, of Trinity College, Dublin, has recently brought to a conclusion a series of papers on Animal Mechanics published in the *Proceedings* of the Royal Society. The ninth of these papers was appointed the Croonian Lecture for the present year, and the tenth paper closes the series.

The most important subject involved in these papers is the experimental determination of the law that regulates fatigue in men and animals, when work is done, so as to bring on fatigue.

Many writers, such as Bouguer, Euler, and others, have laid down mathematical formulæ, connecting the force overcome with the velocity of the movement; but these theoretical speculations have never received the assent of practical engineers.

Venturoli points out a method of observations and experiments which would serve to determine the form of the function which expresses the force in terms of the velocity, after which a few carefully planned experiments would determine the constant coefficients; and he adds that "such a discovery would be of the greatest usefulness to the science of mechanics, upon which it depends, how to employ, to the greatest possible advantage, the force of animal agents."

Dr. Haughton believes that he has found the proper form of this function, by means of experiments, and sums it up in what he calls the *Law of Fatigue*, which he thus expresses:—

The product of the total work done by the rate of work is constant, at the time when fatigue stops the work.

If W denote the total work done, the law of fatigue gives us—

$$W\frac{dW}{dt} = \text{const.}$$

or

$$\frac{W^2}{T} = \text{const.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The experiments made by Dr. Haughton from 1875 to 1880 consisted chiefly in lifting or holding various weights by means of the arms; the law of fatigue giving, in each case, an appropriate equation, with which the results of the experiments were compared. When the experiments consisted in raising weights on the outstretched arms, at fixed rates, the law of fatigue gave the following expression—

$$(w + a)^2 n = A \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where w, n, are the weight held in the hand, and the number of times it is lifted, A is a constant to be determined by experiment, and a another constant depending on the weight of the limb and its appendages.

The equation (2) represents a cubical hyperbola.

The *useful work* done is represented by the equation—

$$w\,n = \frac{A\,w}{(w + a)^2} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This denotes a cuspidal cubic, and the *useful* work is a maximum, when $w = a$, or the weight used is equal to the constant depending on the weight of the limb and its appendages.

When the weights were lowered as well as raised at fixed rates, and no rest at all permitted, the law of fatigue became—

$$\frac{n(1 + \beta^2 t^2)}{t} = A \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where n, t, are the number and time of lift, A is a constant depending on experiment, and β is a constant involving the time of lift (τ) at which the *maximum* work is done.

Equation (4) denotes a cuspidal cubic.

When the weights are held on the palms of the outstretched hands, until the experiment is stopped by fatigue, the law becomes—

$$(w + a)^2 t = A \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where t is the whole time of holding out.

This equation denotes a cubical hyperbola.

The *Law of Fatigue* seems, in itself, probable enough, but of course its real value depends on its agreement with the results of experiment.

If W denote the total work done and R the rate of work, the law becomes, simply—

$$W \times R = \text{const.} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

If different limbs, or animals were used, each working in its own way, and under its own conditions, the *Law of Fatigue* would become—

$$WR = W_1R_1 + W_2R_2 + W_3R_3 + \&c \quad . \quad (7)$$

and the problem for the engineer would be, so to arrange the work and rate of work of each agent employed, as to make the *useful work* a maximum, the work both useful and not useful, in all its parts, remaining subject to the conditions imposed by equation (7).

In using equation (5) in his concluding paper, detailing the results of experiments made on Dr. Alexander Macalister, Dr. Haughton treats a as an unknown quantity, and finds from all the observations its most probable value to be—

$$a = 5{\cdot}68 \text{ lbs.}$$

This result was compared with that of direct measurements made on Dr. Macalister himself, and indirect measurements made on the dead subject, from all of which Dr. Haughton concluded the value of a to be—

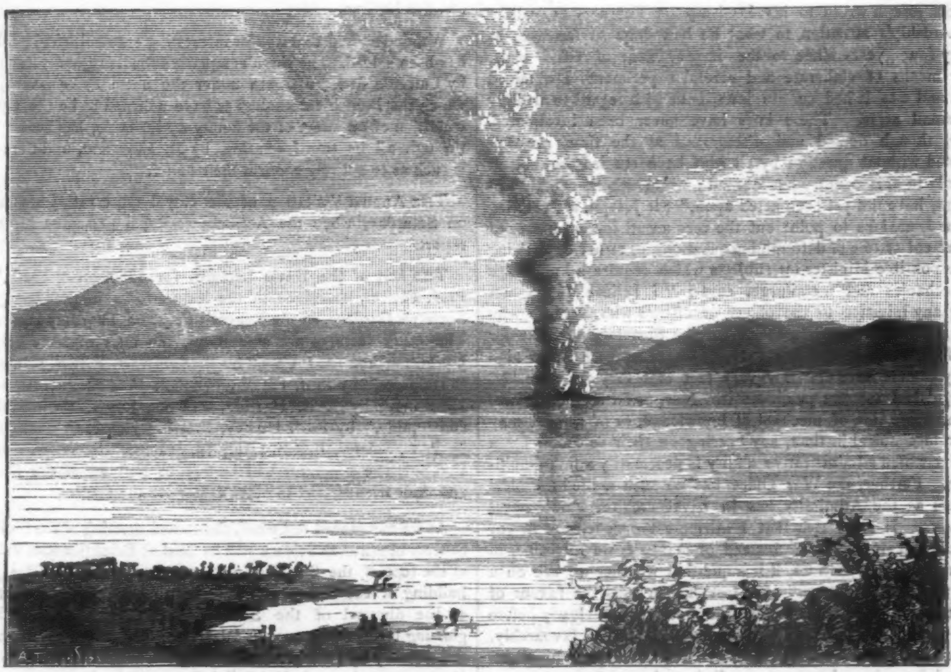
$a = 5{\cdot}56$ lbs. $\pm\ 0{\cdot}125$ (possible error).

This result agrees closely with that calculated from the law of fatigue.

It should be added that a proposal was made by Dr. Haughton to Dr. Macalister to make the experiment conclusive by direct amputation of his scapula, a course which he, unreasonably, objected to, as he draws the line of "vivisection" at frogs.

A LACUSTRINE VOLCANO

IN a recent number of *La Nature* further details, furnished by the French Consul of San Salvador, M. J. Laferrière, are given concerning the recent volcanic phenomenon in Lake Ilopango in that State. The accompanying illustration, from a photograph, will show the nature of the crater which has risen in the midst of the lake. Earthquakes were felt in San Salvador in the first half of January of this year; there were three strong shocks, less violent, however, than those of 1876. These earthquakes had their centre in the vicinity of Lake Ilopango, in the midst of which rose three volcanic openings connected with each other. This new crater, which, seen from a distance as in the illustration, appears a small islet, rises above the surface of the water, however, about twenty metres. An attempt was made to approach it in a boat, but the waters were all in a state of ebullition from contact with the burning rock, and gave off torrents of steam. An abundant column of smoke rose in the air, assuming the aspect of an immense cloud, which was seen from a great distance, and formed an imposing spectacle. The phenomenon was preceded by an exceptional rising of the lake, increased by the abundant winter rains. According to an old tradition the



Aspect of the Volcano in Lake Ilopango. (From a Photograph.)

Spaniards maintain that when the lake rises earthquakes are to be feared. Formerly, also, it was the custom to dig trenches to facilitate the escape of the waters. This practice was followed without intermission for a century, and volcanic phenomena did not appear during all that time. The present phenomena seem to justify this tradition.

If it is difficult to explain the fact it is still interesting to remember that a great number of volcanoes are submarine, that others are found for the most part in islands or in maritime regions, and that water may be one of the feeders of volcanic fires. Lake Ilopango, also known as Lake Cojutepec, is, according to M. Laferrière, a sunk crater. It is in the volcanic line, and it is a general fact in Central America that lakes alternate with volcanic cones. The water of this lake is brackish, very bitter, and almost viscous. It gives off sometimes, here and there, bubbles of sulphohydric acid gas. The lake is about 12 kilometres long by 16 broad; the depth is unknown. It is about 12 kilometres from the city of San Salvador. The Consul of France in Guatemala, M. de Thiersant, states that Lake Ilopango has now a temperature of 38° C. on its shore, and is in complete ebullition round the volcano. All the fishes are cooked and float upon the surface, with a great number of shellfish and other aquatic animals. The volcano continues to rise, and the level of the lake is being gradually lowered.

NOTES

THE candidates whose names we gave in a recent number (vol. xxi. p. 616) were elected Fellows of the Royal Society at the meeting of last Thursday. They are:—Dr. Clifford Allbutt, Prof. J. Attfield, Mr. H. E. Blanford, the Rev. W. H. Dallinger, Mr. Thiselton Dyer, Lieut.-Col. Godwin-Austen, the Bishop of Limerick, Prof. D. E. Hughes, Mr. H. M. Jeffery,

Prof. F. M'Coy, Mr. J. F. Moulton, Prof. C. Niven, Dr. J. Rae, Prof. J. E. Reynolds, Dr. W. A. Tilden.

IN the last number of the Berlin Chemical Society's *Journal* Prof. V. Meyer announces that he has been able to determine the density of iodine vapour at a considerably higher temperature than before, and that he has obtained values closely approximating to those required on the assumption that the gas then consists of *monatomic* iodine molecules. He proposes to extend his observations, if possible, to still higher temperatures, in order to ascertain whether the dissociation can be carried further; for this purpose he proposes to employ the recently described oil furnace of Deville and Troost, which is capable of fusing porcelain, and he hopes to be able to make use of vessels of graphite if those of porcelain are not sufficiently refractory.

FROM a copy of some correspondence which has passed between Sir Joseph Whitworth and Lord Beaconsfield, we see that Sir Joseph wrote to his Lordship on February 21, calling his Lordship's attention to what he had done so far back as twenty-four years since to the improvement of rifled arms. "By means of elaborate and careful experiments I obtained facts, and established certain laws, both with regard to artillery and small arms. These laws have never been invalidated. Some, though denied and disregarded at the time, are now accepted without question by all who have studied the subject, not only in this country but abroad; while others, equally important, have not yet been acted upon." Sir Joseph, after stating that he is anxious to point out the very unsatisfactory nature of the present system of determining questions, or rather of advising the responsible Minister on subjects which require a knowledge of mechanics and metallurgy, says: "I believe I am not doing any injustice to the officer or officers who have, or who have had, for years past, to advise the Secretary of State for War in these matters, when I say they have no such knowledge —they cannot have it. The very fact that they are able and distinguished soldiers precludes it. Nor, as far as I am aware, has the possession of mechanical knowledge, or of what I may term a mechanical instinct, any bearing on their selection for a post for which administrative ability is necessarily a first qualification. Further, the War Office has no such skilled technical advisers as the Admiralty has in naval architects and naval engineers. It is to this that I attribute the deficiency in our artillery and small arms. Instead of being, as we might be, in advance of other nations, it is a question whether we are on a level with some of them." Sir Joseph then asks the favour of an interview, in order to bring this matter more clearly before Lord Beaconsfield, who received the request very favourably. Unfortunately, before Sir Joseph was able to carry out his disinterested intentions, he was compelled to leave the country on account of his health.

A NEW skating surface called "crystal ice" has been invented by Dr. Calantarients of Scarborough. Considering that after all ice is merely a crystalline substance, and that there is no lack of substances that are crystalline at ordinary temperatures, Dr. Calantarients experimented with a variety of salts, and after a time succeeded in making a mixture consisting mainly of carbonate and sulphate of soda, which, when laid as a floor by his plan, can be skated on with ordinary ice-skates; the resistance of the surface is just equal to that of ice, it looks like ice, and indeed when it has been skated on, and got "cut up" a little the deception is quite astonishing; a small experimental floor has been laid in the skating rink at Prince's, and has proved so successful that no doubt a large floor will be laid there or at some other convenient place in the autumn. This floor will obviously have great advantages, both over artificial ice floors, which are very expensive indeed, and over floors for roller-skating. The surface can at any time be made smooth again by steaming with an apparatus for the purpose, and the floor itself when once laid will last for many years. It is interesting to observe that the mixture of salts used contains about 60 per cent. of water of crystallisation, so that after all the floor consists chiefly of solidified water.

MEMBERS of the General Committee and others who have not yet paid their subscriptions to the Clifford Testimonial Fund are requested to forward them to Messrs. Robarts, Lubbock, and Co., or to either of the honorary secretaries, Dr. Corfield, No. 10, Bolton Row, Mayfair, W., and Dr. Lee, No. 6, Savile Row, W.

IN our next number we shall give the first instalment of a paper by Drs. De La Rue and H. W. Müller, on some of their most recent Experimental Researches in Electricity. The second instalment of this paper will be accompanied by a fine steel plate illustrating the experiments, kindly furnished to us by Dr. De La Rue.

WE understand that a most interesting entomological problem has been solved. The singular aquatic animal originally described by Latreille as a crustacean under the name *Prosopistoma*, and which the French entomologists have affirmed to be the aquatic condition of an insect of the family *Ephemeridæ*, has been traced through all its transformations by M. Vayssière, and the result is such as to entirely confirm their belief.

THE Annual Visitation of the Royal Observatory was made on Saturday, when the Astronomer-Royal presented his usual report.

THE first of the Davis Lectures for 1880, on "Teeth," by Prof. Flower, was given in the lecture-room in the Zoological Society's Gardens, in the Regent's Park, on Thursday last week. The other lectures are as follows, the hour of lecture being 5 p.m.:—June 10, "Cats," by Prof. Mivart, F.R.S.; June 17, "Tadpoles," by Prof. Parker, F.R.S.; June 24, "Hawks and Hawking," by J. E. Harting, F.Z.S.; July 1, "Cuttle-fishes and Squids," by Prof. Huxley, F.R.S.; July 8, "Waterfowl," by P. L. Sclater, F.R.S.; July 15, "Birds," by W. A. Forbes, F.Z.S. These lectures will be free to Fellows of the Society and their friends, and to other visitors to the Gardens.

As we announced last week, the annual meeting of the Helvetic Society of Natural Science will be held at Brieg (Canton Valais), at the foot of the Simplon, on September 12 to 15. The great building of the college and the palace of Baron Stockalper are at the disposal of the Society. The committee speak in glowing terms of the various attractions which will be found in this locality by geologists, mineralogists, and entomologists, the "generous wine of Valais" being not the least among the attractions promised to botanists.

THE twelfth meeting of the Scandinavian Naturalists and Physicians will take place at Stockholm on July 7 to 14 inclusive. A numerous attendance is expected from Denmark and Norway, as well as from other countries.

A LARGE German Horticultural Exhibition is planned for the summer of 1882. It will be held at Bremen in connection with the twenty-fifth anniversary of the foundation of the Horticultural Society of that city.

IT is believed that the engineers of the St. Gothard Tunnel will be able to overcome the difficulty arising from the threatened collapse of the passage in the part known as the "Windy Stretch." According to Prof. Colladon, the strata in this section are composed of a calcareous aluminous schist, which has a great affinity for moisture, and swells enormously on exposure to the air. If a tunnel were made through Mont Blanc, 3,000 metres of similar material would have to be pierced and vaulted.

M. BRESSE has been elected to fill the place vacated by the death of General Morin in the Section of Mechanics of the Paris Academy of Sciences.

THE Vesuvius railway was opened on the 6th inst. with much ceremony. It was found to work with perfect satisfaction.

AN experiment with Jamin's electric candle was made on a large scale at the works of the Compagnie Générale d'Electricité, 67, Avenue du Marine, Paris, on June 3. About 1,900 people had been invited, amongst them the principal authorities of the French Republic. The light was found steady, but it remains to be seen whether the expense is smaller than with other systems, and the apparatus can work during a series of days. The candles are moved by a combination analogous to Wild's patent. The weight of wire utilised for each of these frames is 600 to 700 grammes, which shows a length of about 80 metres. M. Jamin wants tension for working his candles, and his Gramme machines rotated with a very great velocity. The scene was very picturesque and the general impression was good, although not enthusiastic, as has been reported in several political papers.

THE Swiss Naturalists Association have decided to erect the Meteorological Observatory, the establishment of which was recommended to them by the International Meteorological Congress which met at Rome last year, upon the Säntis Mountain, in the canton of Appenzell. This peak is better adapted for the purposes of meteorological observation than any other one in Switzerland, on account of its comparatively isolated position. The observatory will cost about 320*l.*, besides which 360*l.* will be spent annually for its maintenance and staff.

MR. G. H. KINAHAN writes us that a wooden hut has been discovered lately under sixteen feet of bog by Thos. Plunkett, M.R.I.A., of Enniskillen. It is remarkable that this structure is at the same depth as the similar structure found at Drumkelin, and described by Wilde in the Catalogue of the Royal Irish Academy.

A LARGE crowd is attracted every night to the Palais de l'Industrie, Paris, where are burning regularly 400 Jablockhoff lights, on the occasion of the Exposition des Beaux Arts, a floral exhibition having taken place in the nave from June 1 to 10, the scene in the nave surpassing description.

ELECTRIC light experiments on a large scale will be conducted with Wild candles at the Universal Exhibition of Melun. The gardens will be opened every night and lighted by electricity.

AN international exhibition was opened at Brussels on June 1 by the king. It is a private speculation, which must not be confounded with the national exhibition which will be opened on June 19, and is the only official display in the capital of Belgium.

M. MARCHE has invented in Paris a new telephone, which he calls electrophone, and which works with an induction coil. The induction current is sent from a distance which is said to be very large, and the hearing is said to be satisfactory.

M. CAILLERET, a telegraphist of Lille (Nord), discovered a new method of rotating the electro-magnetic gyroscope with any induction coil. It is to employ the thin wire as an inductor, and the thick one for sending the induction current to the coil.

A PROSPECTING party, despatched by the Queensland Government, is stated to have discovered a very rich gold-field on the Sefton River in the north of the colony. An examination of the country along the east coast of Cape York Peninsula has not, however, proved successful.

IT is stated that at Wickham, about 100 miles south of Sydney, New South Wales, two surface bands of metallic stone of considerable width have just been discovered. On analysis it is found that there is a large amount of gold and silver in one of these, while the other contains over 60 per cent. of iron with traces only of gold. A large and enormously valuable diamond is also said to have been discovered in the same locality.

THE Naples correspondent of the *Daily News* states that twelve miles south of Sciacca, on the coast of Sicily, an exceedingly rich bank of corals has been discovered, which is even more important than the one found in 1876 in the same waters.

MR. DAVID BOGUE has now at press and will shortly publish a new work, viz., "Birds, Fishes, and Cetacea of Belfast Lough," by Mr. R. Lloyd Patterson, vice-president of Belfast Natural History Society, and president of Belfast Chamber of Commerce, son of the late Robert Patterson, F.R.S. The book will form an interesting and valuable addition to this branch of natural history.

A TERRIBLE forest fire took place in the Harz Mountains on May 27 last. The whole forest of the Great Jügelsberg, near Goslar, is destroyed.

THE forty-fourth general meeting of the Saxon and Thuringian Natural History Society took place at Nordhausen on May 18 and 19 last. The Society numbers between 300 and 400 members.

THE nights of May 18 and 19 were fatal to almost all vineyards on the banks of the Rhine and its tributaries. The young shoots on most of the vines were killed by the frost, which was intense.

AN interesting novelty in the German book-market is "Upilio Faimali, Memoiren eines Thierbändigers," collected by Paul Mantegazza. It is published by Winter, of Heidelberg. Faimali was one of the few tamers of wild animals who gained universal reputation. The book contains interesting narratives of his numerous adventures with various beasts.

ON May 11 last the statue of the late M. Quetelet was unveiled in the gardens of the Brussels Academy buildings. He is represented in a sitting posture, his left hand rests upon a large celestial globe, and he holds a pen in his right. The expressive features are said to be an excellent likeness.

A CURIOUS survival of mediæval superstition has cropped up in a rumour which obtains credence in the West of England, that Balmain's luminous paint is prepared with *human fat*, in order to give it its phosphorescent properties!

ON the Schleswig coast in the Little Belt the establishment of oyster beds is engaging the active attention of the authorities. One million and a half of small oysters have been "sown out" between the Gjenner Bay and the Danish frontier near Heilsminde.

OUR ASTRONOMICAL COLUMN

WINNECKE'S COMET.—In No. 2,314 of the *Astronomische Nachrichten* Prof. v. Oppolzer has a note of more than ordinary interest on the motion of this body as investigated by his own calculations. He states that it results from his computation of the perturbations with the object of connecting the three appearances of 1858, 1869, and 1875 that a satisfactory agreement cannot be found without one of two hypotheses; either the mass of Jupiter must be diminished to $\frac{1}{1051}$, or there is a necessity of admitting the existence of a similar extraordinary influence upon the motion of this comet to that first pointed out by Encke in the motion of the comet which bears his name. Prof. Oppolzer finds an acceleration in the mean daily sidereal motion of $0''.01439$ after one revolution, a result which, he remarks, is in close accordance with his earlier one, deduced by a provisional calculation of

the perturbations, from the observations made at the comet's appearance in the summer of 1819. He infers from his researches upon Winnecke's comet a value for Encke's force designated by U, differing little from that assigned by Encke from his discussion of the motion of his comet, the more satisfactory considering that much latitude must be allowed in this direction. He further observes that with U = $\frac{1}{100}$ the effect upon the motion of Faye's comet would be so small that it is necessarily mixed up with certainty in the values of the perturbations; it will be remembered that Prof. Axel-Möller, who has laboured so admirably to follow up with every precision the motion of Faye's comet, has not, since his computations assumed their present refined form, been able to detect any abnormal effect upon it.

With regard to a diminution in the mass of Jupiter it is to be remarked that all the newer reliable determinations have confirmed the value deduced by Bessel from the elongations of the satellites, including that inferred by Prof. Krueger from the perturbations of Themis, and that which Dr. Axel-Möller has found from his researches on the motion of Faye's comet. Such diminution, therefore, appears inadmissible.

THE IMPERIAL OBSERVATORY, STRASSBURG.—In a communication to the *Astronomisches Gesellschaft* Prof. Winnecke has given details of the construction and instrumental equipment of this new establishment, which we cannot doubt, under his skilful and energetic direction, is destined to take its place amongst the most prominent of astronomical institutions. The principal instruments are—(1) the meridian circle, with object-glass of 6·4 inches aperture, which has been constructed by Repsold and was completed several years since; (2) the alt-azimuth, of 5·35 inches aperture and 4·9 feet focal length, also by Repsold; (3) the refractor, of 19·2 inches aperture and 23 feet focal length, by Merz, but mounted by Repsold, the object-glass being found to be of great excellence; (4) an "orbit-sweeper," constructed according to the design of Sir George Airy, as explained in the *Monthly Notices* of the Royal Astronomical Society, vol. xxi. p. 158; this is, so far as we know, the only instrument of the kind yet mounted, and has been used for some time by Prof. Winnecke in the provisional observatory at Strassburg; the aperture of the object-glass is 6·4 inches, which is not greater than it is essential to provide for the advantageous use of the peculiar mounting. We may hear of the application of the "orbit-sweeper" to the search (which it is not too soon to commence) for the comet of 1812, and later on for Olbers' comet of 1815, neither of which bodies will admit of accurate prediction. A plan of the buildings and grounds accompanies Prof. Winnecke's notice in the *Vierteljahrsschrift*.

THE COMPANION OF SIRIUS.—Mr. Burnham publishes mean results of numerous measures of the small companion of Sirius made with the 18-inch refractor at Chicago in the years 1877-80. We subjoin them with the errors indicated for Prof. Auwers' ephemeris in his *Untersuchungen über veränderliche Eigenbewegungen*:—

Epoch.	Position.	Error of ephemeris.	Distance.	Error of ephemeris.
1878·01	52·4	+6·0	10·83	−0·78
1879·13	50·7	+5·5	10·44	−0·77
1880·11	48·3	+5·7	10·00	−0·72

METEOROLOGICAL NOTES

AMONG the interesting papers which appear in the *Annales du Bureau Central Météorologique de France* for 1878 there is one by Prof. Hildebrandsson, of peculiar value, On the Freezing and Breaking-up of the Ice on the Lakes, the Epochs of Vegetation, and the Migration of Birds in Sweden, based on the observations made by a numerous staff of observers scattered over the country. The paper is illustrated by a diagram showing the seasonal distribution of temperature for ten of the more typical climates of Sweden, and by twelve maps indicating the geographical distribution of the physical and biological phenomena under discussion. Since the lakes of Sweden, which occupy a twelfth part of its entire superficies, exert powerful and diverse influences on plant and animal life, according as they are frozen or open, special attention has been directed to their examination. The results show that while the lakes in the extreme south are covered with ice on an average of ninety days in the year, those in the extreme north are 230 days bound with ice. The average date of the freezing of the lakes in the north is October 10, whereas in the south this does not take place till December 10. On the other hand, the ice breaks up in the southern lakes on April 1, but in the north not until the first week of June. The maps show the decided manner in which the curves are deflected and modified by such extensive sheets of water as are presented by Lakes Wener, Wetter, and Maelar, by height above the sea, and by the Atlantic in different seasons. During the freezing of the lakes the south-west winds of the Atlantic attain a maximum force and frequency, and under this influence the high lakes to westward of the head of the Gulf of Bothnia do not freeze till November 30, or six weeks later than the lakes in the same latitude near Haparanda. On the contrary, at the time of the breaking-up of the ice in spring, easterly winds are prevalent, and the ice on the lakes near the head of the Gulf of Bothnia breaks up four weeks earlier than that of the more elevated lakes to westward. An interesting examination is made of the dates of the breaking-up of the ice on Lake Maelar at Westerås from 1712 to 1871, and from a comparison of the averages of each of the ten-year periods it is seen that the earliest was April 14 for the decade 1722-31, and the latest, May 5, for 1802-11. Whilst the results for these 160 years indicate considerable fluctuations, they give no countenance to the idea that any permanent change has taken place in the climate of Sweden. Three maps show the number of days in which the plants that flower in the extreme south in April, and those in May, come successively into bloom, and the leafing of trees occurs at different places on advancing northward. As regards the plants which come into bloom in the south in April, their time of flowering is forty-five days later at the head of the Gulf of Bothnia, and sixty days later in the elevated districts to westward, but as regards the plants which bloom in the south in May, the times are only twenty-five and thirty-five days. The curves of the May flowers are closely coincident with the curves representing the breaking-up of the ice of the lakes. The time taken for the advance northward from the south to the head of the Gulf of Bothnia is twenty-three days for the leafing of trees and the flowers of May, whereas the time taken by the April flowers is forty-three days. The curves showing the times of arrival of four of the more marked of the migratory birds differ much from each other. The lark arrives in the south on March 1, and in the north on May 1, and the arrangement of the curves of arrival closely agrees with the curves showing the breaking-up of the ice of the lakes but a month earlier. As regards however the wild goose, the cuckoo, and the woodcock, the curves showing their arrival assume a different form, and point to an intimate connection subsisting between the arrivals and the temperature of the place at which they arrive.

To mark the high value they set on carefully-made observations, the Council of the Scientific Association of France have awarded medals to Lieut. Pouvreau, serving on the line from Havre to New York, Lieut. Benoît, of the *Yang-Tsé*, plying between Marseilles and Shanghai, and Captain Corenwinder, of the *Grenadier*, Dunkirk, for the meteorological observations made by them, these comprising, in addition to the usual observations, numerous and elaborate notes on whirlwinds and other special phenomena. At the same time a medal was awarded to M. Vidal, schoolmaster at Fraisse, Hérault, for a peculiarly interesting series of observations made by him during the past fifteen years, regularly in winter as well as in summer, at a height of 3,150 feet above the sea. M. Vidal has also, from his wide and varied knowledge of the natural sciences, rendered effective service to scientific men in their excursions into the higher districts of that part of France.

PROF. FORNIONI has recently described to the Istituto Lombardo (*Rendiconti*, vol. xiii. fasc. 3) a simple nefodoscope, or instrument for measuring the direction of motion of clouds (the instrument of the kind known as that of Braun being thought expensive and inconvenient to use). It consists of a flat compass case with pivoted needle, above which is fixed horizontally a plane mirror occupying the whole of the case. On the surface of the glass are drawn diagonal lines corresponding to the rise of winds. The amalgam is removed in a narrow arc extending from north to north-west, so that the end of the needle may be seen for the purpose of orientation, and this transparent arc is graduated. A rod with terminal eye, freely pivoted on the edge of the case, completes the instrument. When the direction of a given cloud is to be determined, the nefodoscope is placed in a horizontal plane and properly oriented. The rod

is then moved to such a position that the observer's eye sees three points in a straight line, viz., the eye of the rod, the centre of the mirror, and the reflected image of a selected point of the cloud. The direction of the displacement which the latter undergoes after a time, proportional to the velocity of the cloud and inversely as its distance, is the required direction.

THE Report of the Royal Society of Tasmania for 1878 includes the tri-daily meteorological observations made at Hobart Town by Mr. Francis Abbott, so long an enthusiastic observer there, together with the annual abstract of his observations, and also an annual abstract of observations made by Mr. W. E. Shoobridge at New Norfolk, situated about fifteen miles from Hobart Town, higher up the Derwent. Observations were formerly made at Port Arthur, Swansea, Swan Island, and Kent's Group, viz., from 1861 to 1866, but at present Hobart Town and New Norfolk appear to be the only meteorological stations in the colony, the observations at Hobart Town dating from 1841, and those at New Norfolk from 1874. Mr. Abbott prints also his daily observations made at 10.33 P.M. in connection with Gen. Myer's international synchronous observations, the importance of which we have several times had occasion to refer to in describing the United States weather maps. The regular hours of observation are 7.30 A.M. and 4.30 P.M., these hours having been adopted since 1876, as stated in the Report, with the view of assimilating the records more closely with those of stations in Europe, America, &c., in order to co-operate in a system of international meteorology. These hours have not been happily chosen for general meteorological purposes, particularly since it is the practice to adopt as the mean temperatures of the separate months simply the mean of the observations at the above hours, which, whilst only very slightly below the true mean during the winter months, are from 1°·5 to 2°·8 too high for the four warmest months of the year.

PHYSICAL NOTES

AT the last meeting of the Physical Society of Paris some new and curious experiments upon the so-called magic mirrors of Japan were shown by M. Duboscq and discoursed upon by M. Bertin. Mirrors having a sufficiently true surface to give a fairly good virtual image of an object held near to them may yet be very irregular in the actual curvature of the surface and produce a very irregular real image of a luminous point reflected by the mirror upon a screen. If such a mirror be warmed the thinner portions change their curvature, becoming flatter, and yield dark corresponding patches in the disk of reflected light. A mirror which gives very imperfect effects when cold will give very good ones when heated. If, by means of a condensing pump, a uniform pressure is exerted against the back of the mirror, the thinner portions are more affected than the thick portions, and therefore, as viewed from the front, become less concave than the rest of the surface, the result upon the reflected beam being that the pattern of the thicker parts comes out bright on the darker ground of the image. Lastly, if a mirror be *cast* upon the face of the original mirror, and then polished, it will when warmed become a "magic" mirror, though when cold it yields only a uniformly illuminated disk upon the screen. This last experiment alone suffices to show that the cause of the reputed magical property is to be sought not in any difference of reflective power in different parts of the surface, but in slight differences of curvature of the surface.

A NEW zinc-carbon battery, the patent of Mr. R. Anderson, is announced. The exciting liquid is a mixture of hydrochloric acid, bichromate of potash, and of certain other "salts" in a mixture, for the composition of which Mr. Anderson claims the protection of the patent. The battery may be used either with or without a porous cell. It is stated that the E.M.F. of this battery is as high as 2·15 volts, that it is remarkably free from local action and internal resistance, and that it is very constant, one cell having twelve square inches of effective surface of the zinc, giving for seventy hours a constant current.

MR. A. A. MICHELSON, of the U.S. Navy, has communicated to the New York Academy of Sciences some interesting observations upon the diffraction and polarisation effects produced by passing light through a narrow slit. If a fine adjustable slit be narrowed down very greatly, the coloured diffraction fringes widen out until when the width of the slit is reduced to less than one-fiftieth of a millimetre, the central space only is seen, and appears of a faint bluish tint. Moreover, the light so transmitted exhibits traces of polarisation when regarded through a Nicol prism. If the slit is still further narrowed, the depth of the tint and the amount of polarisation increase, until, when a width of only one-thousandth of a millimetre is reached, the colour becomes a deep violet and is perfectly polarised. In this experiment the Nicol prism may be used either as polariser or as analyser. Slits of iron, brass, and obsidian produce identical results, though with the latter material, which can probably be more finely worked, the effects are the most pronounced. The polarisation is in a plane at right angles to the length of the slit. The phenomenon is best observed by using direct sunlight, placing the slit as near the eye as possible, and analysing with a double-image prism, thus enabling the delicate changes of tint to be observed by comparison. The possible explanation that the light which thus comes through the slit is reflected at its edges accords with the direction of the plane of polarisation; but there remains the difficulty that these effects should take place with all widths of slit and vary with the nature of the materials. One important point is that a slit of this degree of fineness admits the shorter waves of light more freely than the longer waves.

LORD RAYLEIGH showed a curious experiment in colour-combinations to the Physical Society, when he produced a yellow liquid by mixing a blue solution of litmus with a red solution of bichromate of potash. We recollect a kindred experiment which is even more curious, namely, the production of white by the mixture of crimson and green. An aqueous solution of cuprous chloride and a solution of rosaniline acetate in amylic alcohol are placed in a bottle in certain relative quantities. The crimson solution floats upon the green solution. But when shaken up together both colours disappear, and the mixture is simply a turbid greyish white.

MR. PREECE's new microphone or telephone transmitter has at least the merit that it surpasses all others for simplicity. A very thin wire stretched between two points forms part of a circuit containing a Bell telephone and a small battery. When it is set vibrating by sounds, the vibrations, by varying the strain to which it is subjected, alter its conductivity, probably by producing alterations in its temperature.

M. OBALSKI describes a pretty magnetic curiosity to the Académie des Sciences. Two magnetic needles are hung vertically by fine threads, their unlike poles being opposite one another. Below them is a vessel containing water, its surface not quite touching the needles. They are hung so far apart as not to move towards one another. The level of the water is now quietly raised by letting a further quantity flow in from below. As soon as the water covers the lower ends of the needles they begin to approach one another, and when they are nearly immersed they rush together. The effect appears to be due to the fact that when the gravitation force downwards is partly counteracted by the upward hydrostatic force due to immersion, the magnetic force, being relatively greater, is able to assert itself.

THE phenomenon of luminosity of a (especially) negative electrode of small surface used in electrolysis of, *e.g.*, acidulated water, has been investigated by Prof. Colley of Kasan (*Jour. de Phys.*, May). Examining the light (which Slouguinoff found associated with an intermittence of the current) with a rotating mirror, he saw on a weakly luminous ground a multitude of bright star-like points, each appearing only an instant, and distributed without apparent regularity. The spectrum of the negative electrode was found to be composed of bright lines, determined both by the liquid and the substance of the electrode. Some physicists have thought that the electrode is considerably heated, and that the liquid round it assumes the spheroidal state, being separated by a layer of vapour. M. Colley finds that with a very strong current the electrode indeed becomes incandescent, and the liquid ceases to moisten it. He shows, however, that the illumination may be produced on an electrode quite cold, and he seeks the cause of production of vapour (of which he supposes the isolating layer to consist) in the high temperature of the liquid immediately surrounding the electrode (not in that of the electrode itself), heat being developed by reason of the small surface and small conductivity of a thin sheath of liquid. With a pile of 100 Bunsen couples, water containing 5 per cent. of sulphuric acid, and an electrode of 10 sq. mm. surface, 1·3 seconds would suffice to raise the layer next the electrode from 20° to 100° C. The sheath of gas

formed round the electrode may serve as germ for formation of a layer of vapours, and this being once formed, the discharges occur by sparks.

GEOGRAPHICAL NOTES

WE are delighted to find that our good neighbours, the French, will not be behind the rest of the scientific world in exploring the depths of the sea. A large Government steamer, the *Travailleur*, will be at Bayonne on the 15th of next month to undertake a dredging expedition along the Atlantic coasts of Spain, under the charge of Prof. Milne-Edwards and the Marquis de Folin. Dr. Gwyn Jeffreys and the Rev. Mr. Norman have been officially invited to take part in this expedition. The Dutch are also making arrangements for a dredging expedition in the West Indies.

FROM a note in the June number of the *American Naturalist* it seems extremely likely that the U.S. Senate will endorse the approval given to the Howgate Polar Expedition by the House of Representatives. The steamer *Gulnare*, 230 tons burden, is being fitted up, and will have a crew of fifteen officers and men. The observing party, which will be left at the station as near Lady Franklin Bay as possible, will consist of twenty-five men, including the necessary scientific corps. A house of wood is being fitted up for the men to winter in on the shores of Discovery Bay, and a steam launch will form part of the expedition. "In making this report the committee respectfully state and report that the object of the bill, as is shown by its terms, is to authorise a temporary station to be selected within the Arctic circle, for the purpose of making scientific discoveries, explorations, and observations, obtaining all possible facts and knowledge in relation to the magnetic currents of the earth, the influence of ice-floes therefrom upon the winds and seasons, and upon the currents of the ocean, as well as other matters incidental thereto, developing and discovering at the same time other and new whale-fisheries, now so material in many respects to this country. It is, again, the object of this bill that this expedition, having such scientific observations in view, shall be regularly made for a series of years under such restrictions of military discipline as will insure regularity and accuracy, and give the fullest possible return for the necessary expenditure; and again, in view of the fact that either the governments directly, or scientific corps under their authority, of Germany, Holland, Norway, Sweden, Austria, Denmark, and Russia, have concurrently agreed to establish similar stations, with like object, during the year 1880, it is believed that the interests and policy of our people concur in demanding that the United States should co-operate in the grand efforts to be thus made in the solution of the mysteries and secrets of the North Polar seas, upon which, in the opinion of scientists, depends so much that affects the health and wealth of the human race." This station will form one of the series of International Arctic Observatories to which we have already referred.

DURING the past year H.M.S. *Alert*, first under Sir G. S. Nares, and afterwards under Capt. Maclear, was engaged in very useful service on the west coast of South America, chiefly in examining the channels in about 50° S. lat. Trinidad Channel, which opens out a clear passage to the Pacific 160 miles north of Magellan Strait, has been carefully surveyed, together with its various ports and anchorages. This channel forms a valuable addition to our knowledge of these waters, as it will enable vessels bound westward to avoid the heavy sea often met with in the higher south latitude. Its southern shores are bounded by bold rugged mountains rising abruptly from the sea, and on the north side a low wooded country lies between the sea and the snow-clad mountains in the distance. The *Alert* also visited St. Felix and St. Ambrose Islands, which, owing to the depth of the soundings obtained, are thought to be unconnected with both the South American continent and the San Juan Fernandez group. Capt. Maclear describes St. Ambrose Island as volcanic, composed of lava in horizontal strata, intersected vertically by masses of basalt. Vegetation is scant, and the island is without water; though frequented by sea-birds, its sides are too steep and rugged for guano to collect. From the soundings it would seem that this, as well as the other islands, rises as an isolated mountain from a submarine plateau.

AT the meeting of the Paris Geographical Society of May 7 a Greek physician, Dr. Panagiotès Potagos, was introduced by MM. Ujfalvy and Duveyrier as one of the most extensive travellers of our time. M. Potagos, we are told, has since 1867, beginning at Tripoli in Asia Minor, visited Teheran, skirted the Paropamisus on his way to Medjid, Herat, Kandahar and Kabul; crossed the Hindu Kush by one of the most difficult passes, traversed Badakshan, Wakhan, and all Kashgaria, arriving at Hami in 1871. Thence he went to Ulussutai in the heart of Mongolia, returning to Hami, where all his notes and collections were destroyed, and he himself kept prisoner for more than a year. Thence continuing his journey, he reached Kulja, and returned to Europe by Semipalatinsk, Omsk, Moscow, and St. Petersburg. After staying at Salonica for two years, he went to Bombay and Peshawur, descended the Indus to Karachi, thence to Bunder-Abbas in Persia, crossed the mountains of Laristan, and made his way to Kabul, reaching India again by the Kurrum Valley, meeting Major Cavagnari on his way. From Bombay he went to East Africa, and penetrated into the interior farther than Schweinfurth. The principal sphere of his African journeys seems to have been in the region of the River Beré, which M. Deveyrier is of opinion is the Wellé of Schweinfurth, but which, according to M. Potagos, cannot be connected with the Aruwimi of Stanley, but rather with the basin of the Shari. The observations of M. Potagos are, however, too vague to be of much scientific value, unless, indeed, further details be forthcoming.

MR. LAURENCE OLIPHANT has lately returned to England from a journey of exploration on the eastern side of the River Jordan, and is, we believe, engaged in preparing for publication an account of the results of his investigations.

THE map of Equatorial Africa, on the scale of 15·8 miles to one inch, on which Mr. E. G. Ravenstein has for some time been engaged for the Geographical Society, is stated to be approaching completion, and it is expected that the lithographed sheets will be ready during the summer. An analytical catalogue of works on African travel and geography, including papers in periodicals, is being compiled at the same time.

MR. STANFORD has just published a fine new wall map of New Zealand, on the scale of seventeen miles to an inch. The whole of the coast line, together with the details of harbours and banks of these islands, has been carefully reduced from the most recent Admiralty Charts. The interior details of rivers and mountains, roads and railways, towns and villages, have been plotted in from the various Government surveys and partly from private sources. Although not over-crowded with names, it contains, besides the chief physical features, the names of all villages and other centres of population, together with the names of many places of interest, such as the geysers or hot springs and the boiling lakes of the North Island. The principal Maori tribal names are also given over the areas once occupied by them. The map is coloured to show the boundaries of the new administrative divisions, all of which are named. The large size, accuracy, and clearness of this map render it eminently useful for teaching purposes.

THE annual address of Chief Justice Daly, President of the American Geographical Society, on the Geographical Work of the World in 1878 and 1879, is as usual, remarkably comprehensive and well arranged; indeed it is the best summary of the subject we have seen.

L'Exploration of June 2 contains an interesting article on the various explorations of M. Paul Soleillet in Africa. There is also a map of the French possessions and factories on the coast of Guinea.

"ANGLO-CANADIAN" sends us the draught of a scheme for reaching the North Pole by balloon in comparatively few days, at a cost which must take the gas completely out of the elaborate and expensive scheme of Commander Cheyne. Our correspondent has patented a directable balloon, which he maintains is capable of being moved at a rapid rate in any direction. We need not enter into the details of his plan, which reads very glibly, but which we should like to see subjected to rigid scientific tests. The whole scheme is to cost only 2,000*l.*, including a steamer to be chartered to Spitzbergen to take the necessary compressed gas which "Anglo-Canadian" would use as fuel. We do not attach much importance to the attainment of the Pole, and should prefer to see any money that can be raised for Arctic exploration in this country devoted to the founding of one of those international series of Arctic observations from which England is conspicuously absent.

IT may interest such of our readers as are conversant with the German language to know that in the course of the present month Dr. Ernst von Hesse Wartegg will deliver a lecture at the German Athenæum (93, Mortimer Street, W.), entitled "Das Leben der Beduinen." The secretary of the institution will furnish all particulars regarding exact date and admission to the lecture on application by letter.

AFTER the example of the German and Austrian Alpine Clubs, a Bohemian Mountain Club is now in course of formation.

THE authors of Sweden and Finnland have edited a festive paper, "Nordostpassagen," in honour of Prof. Nordenskjöld's return, which deserves high commendation, both with regard to text and illustrations. It is published by C. E. Fritze, of Stockholm.

IN a letter from M. Berlioux, read at the Paris Academy of Sciences on May 31, the writer attempts to prove from the last expedition of Dr. Rohlfs in the Eastern Sahara the marvellous correctness of Ptolemy's Tables.

IT is stated that Col. Gordon, who has resigned his post on the staff of Lord Ripon, is to proceed to Zanzibar to join the Belgian African exploring expedition.

THE question of the speedy completion of the Ordnance Survey came up in the House of Commons last Friday, when there was an almost unanimous consensus of opinion that Government ought at once to advance as much money as was necessary to complete the work. The reply of Mr. Adam and Mr. Gladstone was virtually a *non possumus*. It was not so much the difficulty of advancing the money as of obtaining the necessary amount of skilled labour to carry on the work under pressure. At the present rate the survey cannot be completed for eighteen years.

DR. SIEMENS' NEWEST ELECTRICAL RESULTS

A PAPER was read on Thursday last before the Society of Telegraph Engineers by Dr. Siemens, F.R.S., upon "Recent Applications of the Dynamo-Electric Current to Metallurgy, Horticulture, and the Transmission of Power." The author first referred to the inaugural address which he had given before the Society on his election to his second presidency, wherein he drew attention to the applicability of the dynamo-electric current to purposes beyond the range of what electricity had theretofore been employed in effecting. On the present occasion he corroborated his statements by a reference to recent experimental results of his own.

The first part of the paper had reference to an electric furnace. This furnace consists of any ordinary crucible of plumbago or other highly refractory material, which is placed in a metallic jacket or outer casing, the intervening space being filled up with pounded charcoal or other bad conductor of heat. A hole is pierced through the bottom of the crucible for the admission of a rod of iron, platinum, or dense carbon, such as is used in electric illumination. The cover of the crucible is also pierced for the reception of the negative electrode, by preference a cylinder of compressed carbon of comparatively large dimensions. At the end of a beam supported at its centre is suspended the negative electrode by means of a strip of copper, or other good conductor of electricity, the other end of the beam being attached to a hollow cylinder of iron free to move vertically within a solenoid coil of wire, presenting a total resistance of about fifty units or ohms. By means of a sliding weight the preponderance of weight of the beam in the direction of the solenoid can be varied so as to balance the magnetic force with which the hollow iron cylinder is drawn into the coil. One end of the solenoid coil is connected with the positive, and the other with the negative pole of the electric arc, and, being a coil of high resistance, its attractive force on the iron cylinder is proportional to the electromotive force between the two electrodes, or, in other words, to the electrical resistance of the arc itself.

An automatic adjustment of the arc thus arises of great importance to the attainment of advantageous results in the process of electric fusion; without it the resistance of the arc would rapidly diminish with increase of temperature of the heated atmosphere within the crucible, and heat would be developed in the dynamo-electric machine to the prejudice of the electric furnace. The sudden sinking or change in electrical resistance of the material undergoing fusion would, on the other hand, cause sudden increase in the resistance of the arc, with a likelihood of its extinction, if such self-adjusting action did not take place.

Another important element of success in electric fusion consists in constituting the material to be fused the positive pole of the electric arc. It is well known that it is at the positive pole that the heat is principally developed, and fusion of the material constituting the positive pole takes place even before the crucible itself is heated up to the same degree. This principle of action is of course applicable only to the melting of metals and other electrical conductors, such as metallic oxides, which constitute the materials generally operated upon in metallurgical processes. In operating upon non-conductive earth or upon gases it becomes necessary to provide a non destructible positive pole, such as platinum or iridium, which may, however, undergo fusion and form a little pool at the bottom of the crucible.

In this electrical furnace some time, of course, is occupied to bring the temperature of the crucible itself up to a considerable degree, but it is surprising how rapidly an accumulation of heat takes place. In working with the modified medium-sized dynamo machine, capable of producing thirty-six webers of current with an expenditure of four horse-power, and which, if used for illuminating purposes, produces a light equal to 6,000 candles, I find that a crucible of about twenty centimetres in depth, immersed in a non-conductive material, is raised up to a white heat in less than half an hour, and the fusion of one kilogram of steel is effected within, say, another half-hour, successive fusions being effected in somewhat diminishing intervals of time. It is quite feasible to carry on this process upon a still larger scale by increasing the power of the dynamo-electric machine and the size of the crucibles.

It was shown by means of a calculation that this furnace utilises $\frac{1}{3}$ of the horse-power actually expended, and as the efficiency of a good steam-engine is $\frac{1}{5}$, that of the electric furnace is $\frac{1}{3} \times \frac{1}{5} = \frac{1}{15}$. Now as it takes theoretically 450 heat units to melt 1 lb. of steel, there will be required actually $450 \times 15 =$ 6,750 units in working with the electric furnace, or about the heat-energy residing in a pound of ordinary coal. To melt a ton of steel in crucibles in the ordinary air-furnace as practised at Sheffield, $2\frac{1}{2}$ to 3 tons of best Durham coke are consumed. A ton of coal is consumed per ton of steel produced if the regenerative gas furnace is used for heating the crucibles, whilst to produce steel in large quantities on the open hearth of this furnace about 12 cwt. of coal per ton of steel suffice. The electric furnace may therefore be considered as economically superior to the ordinary air-furnace, and, barring some incidental losses not included in the calculation, is nearly equal to the regenerative gas-furnace as far as economy of fuel is concerned. In favour of the electric furnace is an almost unlimited temperature, easy application, a neutral atmosphere within the crucible, and the circumstance that the heat within the crucible is greater than that external to it, whereas in ordinary fusion the temperature of the crucible is higher than that of metal within.

On the occasion of reading the paper a pound of broken files was melted in a cold crucible by means of a current of 72 webers in fifteen minutes, and cast in a liquid state, a second casting being effected in eight minutes. These and other brilliant successes of the new apparatus were hailed with ringing cheers.

In the second portion of the paper, referring to electro-horticulture, the author explained the experiments by means of which he has come to the conclusion that electric light produces the colouring matter chlorophyll in the leaves of plants, that it aids their growth, counteracts the effects of night frosts, and promotes the setting and ripening of fruit in the open air. It appears, further, that, at all events for certain short periods, plants do not require a period of rest during the twenty-four hours, but make increased and vigorous progress if subjected during daytime to sunlight and to electric light at night. These observations on combined sun and electric light agree with those made by Dr. Schübeler of Christiania, who found as the result of continued experiment in the north of Europe, during an Arctic summer, that plants, when thus continuously growing, develop more brilliant flowers and larger and more aromatic fruit than when under the alternating influence of light and darkness. As Dr. Siemens has found that under the influence of electric light plants can sustain increased stove heat without collapsing, he is of opinion that forcing may be effected in an electric stove or enclosure containing an electric light, and that horticulturists may thus grow fruit of excellent aroma and flowers of great brilliancy without immediate solar aid. To test what

can be done practically the author has put down a steam-engine and boiler at his country residence near Tunbridge Wells, and intends to test the principles involved upon a working scale during the winter. The steam-engine which drives the dynamo-electric machine during the night for the purpose of giving light is to be employed during the day in transmitting power through an electric conductor to the farm for the purpose of carrying on small farming operations such as turnip, chaff, and wood-cutting, &c. Another interesting question which Dr. Siemens has set himself to answer is to determine which portion of the rays constituting white light is efficacious in producing chlorophyll, starch, and woody fibre, and which in effecting the ripening of fruit. For this purpose arrangements are in preparation to distribute the spectrum of a powerful electric light in a darkened chamber over a series of similar plants exposed *seriatim* to the actinic, light-giving, and thermal portions of the spectrum. Some experiments have been made with solar light in this direction, but no very conclusive results could be obtained, because the short periods of time during which the solar spectrum can be maintained steadily in the same place are so short that the effects produced upon vegetation have not been of a sufficiently decided character; whereas, with the aid of electric light, the same spectrum may be kept on steadily for a series of days without intermission. The author referred shortly to the lamp which he designed for this purpose, having a focus unchangeable in space, and without obstruction to the rays of light falling downward. There is no clockwork; the carbons are pressed forward either by their own weight or by the force of springs, the motion being checked by an abutment against which the carbon presses at the junction of its cylindrical with its conical portion. This is at a distance of $\frac{1}{8}$ inch to $\frac{1}{4}$ inch from the arc centre, when the heat is sufficient to cause the gradual decomposition of the carbon, without being high enough to fuse or injure the metal abutment.

In the third portion of the paper the author refers to the application of electricity as a means of mechanical propulsion. He described the electric railway designed by Dr. Werner Siemens, of Berlin, and tried at a local exhibition held in that city. The rails were insulated from the earth by wooden sleepers, and were in electrical connection with a dynamo-electric machine worked by steam power at the station. A magneto-electric machine on the driving carriage was so fixed and connected with the axle of one pair of wheels as to give motion to the same, the driving axle being severed electrically by the introduction of an insulated washer. A current of electricity is thus passed along one rail to work the magneto-electric machine on the driving carriage, and back by the other rail to the stationary machine on the ground. The author anticipates a large application of the electric railway to adits in mines, to locomotives between neighbouring places, and to tunnels. In fact it is seriously contemplated to apply this system at the St. Gothard tunnel, where the large turbines are available which have been employed in the boring operations.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—In their latest-issued series of statutes for the University of Cambridge, the Commissioners maintain Easter as the boundary between the University Lent and Easter terms, and require three-fourths of each term to be kept by residence. The degree of Bachelor in Surgery is added to the list; but the permission to give degrees to peers and sons of peers who come to the University in youth is limited to the B.A. degree, and the University may prescribe for their examinations and residence by grace. Titular degrees in any of the seven faculties of Arts, Law, Medicine, Surgery, Science, Letters, or Music may be granted to foreigners of distinction and to British subjects who are of conspicuous merit, or who have done good service to the State or to the University. Complete honorary degrees, with right of voting, may be given to those who obtain some University office after residing three terms in the University.

The Demonstrator of Anatomy will superintend a class for Practical Histology during the next long vacation, beginning July 1; another class will be held for Human Osteology. The Cavendish Laboratory also will be open for practical work.

Notice has been given by the Board of Natural Science Studies that next June (1881) there will be a practical examination in all the subjects of the examination in the first part of the Natural Sciences Tripos.

The recent memorials concerning the academical encouragement of the higher education of women are to be considered and reported on by a syndicate consisting of the Vice-Chancellor, Drs. Bateson, Phear, Westcott, and E. C. Clark, Professors Cayley, Adams, Liveing, and Stuart, Messrs. G. F. Browne, Ferrers, E. W. Blore, R. Burn, H. Sidgwick, J. Peile, A. Austen-Leigh, and G. W. Prothero, to report before the end of Lent Term next.

The Sedgwick prize, given every third year for the best essay on some subject in geology or the kindred sciences, open to the competition of all graduates of the University who have resided sixty days during the twelvemonth preceding the day on which the essay must be sent in, has been awarded to Walter Keeping, Inceptor in Arts, of Christ's College. The subject of the essay is, "On the Fossils and Palæontological Affinities of the Neocomian Beds of Upware, Wicken, and Brickhill."

SIR JOHN LUBBOCK has been elected without opposition to represent London University in Parliament.

PROF. HENRICI, F.R.S., has been appointed to the Professorship of Applied Mathematics in University College, London.

GREAT importance has been given to the first session of the Superior Council of Instruction of France, composed of about fifty members, of whom forty have been nominated by the different classes of French teachers, from the Sorbonne to the humblest village school. A decree has granted to each of them a sum of 20 francs a day for the duration of the session, and travelling expenses. M. Jules Ferry opened the session by a speech in which he explained his views, and submitted to the new organisation a programme of reforms. This programme has been sent by the General Assembly to a special commission composed of fifty members appointed to report on it. M. Jules Simon has been appointed president of that commission. It is said that, although approving the general tendency of these reforms, the commission is resolved to protect Greek studies, which had been sacrificed in the Ministerial project. But it agrees to render the study of either the English or the German language an obligation from the admission to the school up to the end of the course of studies. The commission has held already three long sittings for determining these points. The discussion will be long in general sitting. For the first time in the history of France the University has her own parliament to deliberate on all the subjects relating to public instruction. None of these deliberations are to be binding on the Government. All the provisions of the laws are to be voted as formerly by the French Chamber of Deputies and Senate.

SCIENTIFIC SERIALS

THE *Bulletin of the Torrey Botanical Club* is now published in regular monthly parts, instead of at irregular intervals. The papers are of course chiefly of local interest, and that is especially the case with the three numbers which we have received for the current year, though now and then morphological notes by Mr. Meehan and others are of a wider scope. At all events the *Bulletin* gives us in this country a lively idea of the activity of botanical research on the other side of the Atlantic. Mr. W. R. Gerard gives a description and drawing of a fungus new to science, *Simblum rubescens*, belonging to the Phalloidei.

UNDER the new editorship of Mr. James Britten the *Journal of Botany* loses none of its interest. In addition to contributions to phyto-geography, and smaller articles of special interest to the workers in the critical botany of British plants, the following, which have appeared in recent numbers, may be mentioned as being of a wider scope:—Mr. J. G. Baker's Synopsis of the species of *Isoëtes*, a useful contribution to our knowledge of vascular cryptogams; a much-needed review of the British Characeæ (not yet completed), by H. and J. Groves; and the botany of the British Polar Expedition of 1875-6, by Mr. H. C. Hart, the naturalist to the expedition.

THE *Nuovo Giornale Botanico Italiano* continues to be supplied with good and useful papers in the various departments of botany. In the two numbers already published during the present year (vol. xii. Nos. 1 and 2) there are articles by several of the leading Italian botanists. The editor, Prof. Caruel, gives a list of fifty false genera or species of plants founded on teratological or pathological circumstances. In an article on the parasitism of fungi by A. Bertoloni, he divides the class of fungi into two great divisions, according to their mode of life. The

first are true parasites, the mycelium of which, living on the tissues of the host, frequently kills it; the second are false parasites (saprophytes), deriving their nourishment from vegetable substances in various stages of decomposition. The genus *Polyporus* he considers to belong to the first, *Agaricus* to the second of these classes. The common disease of the mulberry-tree he attributes to *Polyporus mori*, not to *Agaricus melleus*, as suggested by Piccone.—A. Mori discusses the old statement of Gasparrini, recently revived by Licopoli, that beneath the stomata of the leaves are cavities, to which Gasparrini gave the name *cistoma*, which are clothed by a continuation of the cuticle. His observations do not lead him to confirm this statement, but rather to the conclusion that the walls of the cavity beneath the stoma consist of ordinary cellulose.

In the number of the *Scottish Naturalist* for April is the commencement of a suggestive article by the Rev. A. Milroy on the value of the names of places in indicating the ancient surface-features of the country. He takes as an example the country on the banks of the Tay below Perth, and shows the light that is thrown by the Saxon and Celtic local names, not only on the ethnological history of the district, but also on the changes which have taken place in its physical features.

The American Naturalist, May, contains:—Edward Burgess, the structure and action of a butterfly's trunk.—J. S. Lippincott, the critics of evolution.—E. H. Yarnall, Hall's second Arctic expedition.—O. T. Mason, sketch of North American anthropology in 1879.—The editor's table, on the Academy of Natural Sciences, Philadelphia.—On the proposed exploration of the ruins of Mexico and Central America—Recent literature.—General notes.—Scientific news.

Journal of the Franklin Institute, May.—Naval architecture, by Mr. Haswell.—Table and diagram for determining the diameters of speed cones when connected by an open belt of constant length, by Mr. Klein.—Experiments with a steam cutter, by Mr. Isherwood.—Eye memory, by Mr. Leland.

SOCIETIES AND ACADEMIES

London

Royal Society, May 13.—"Notice of Further Experimental Researches on the Time Relations of the Excitatory Process in the Ventricle of the Heart of the Frog," by J. Burdon Sanderson, M.D., and F. J. M. Page, B.Sc.

The present paper is a continuation of one previously published by the authors (*Roy. Soc. Proc.*, xxvii. 410). The excitatory state, *i.e.*, the condition produced in any excitable structure, vegetable or animal, by excitation, is characterised (1) by the appearance of electromotive properties in the excited part which did not exist before excitation and cease to exist as soon as its effect is over; (2) by diminished excitability; (3) by the fact that it is propagated from the part first excited to contiguous parts at a rate which is different in different structures and in the same structure at different temperatures. These three conditions are important as being the only characteristics by which the hidden process of excitation constantly reveals itself. By means of the rheotome described by one of the authors, exact measurements have been made of the time relations of the above conditions. The results obtained by Engelmann (*Pflüg. Arch.*, xvii. 68) are then discussed. In forty-seven out of seventy-eight preparations of the ventricle of the frog made by this observer, the leading-off contact nearest the point of excitation became first negative, then positive to the other leading-off contact; in the remaining thirty-one the positive deflection was absent. In the case in which the deflection was of a double character (*Doppelschwankung*), the first phase began 0″·06 after excitation, and rapidly attained its maximum; the reversal of sign took place at 0″·26, and the contacts became equipotential at 0″·5. He estimated the rate of propagation at 50 mm. per second. It will be noticed that these researches of Engelmann refer exclusively to the first half second after excitation, and therefore correspond to what has been termed by the authors of the present paper "the initial phase," and that the "terminal phase" escaped the notice of Engelmann. The method employed in the investigation of the above phenomena, with the aid of the rheotome, is then briefly described. The heart was carefully maintained at a constant temperature by being placed on a lacquered brass box, through which flowed a stream of water at the desired temperature. The following table gives

Time after excitation, at which galvanometric circuit was opened, the period of closure being 0″·1 ...	0″·1	0″·2	0″·3	0″·4	0″·5	0″·6	0″·7	0″·8	0″·9	1″·0
Deflections	−42	−3	0	0	0	0	0	0	0	0
Time after excitation, at which galvanometric circuit was opened, the period of closure being 0″·1 ...	1″·1	1″·2	1″·3	1″·4	1″·5	1″·6	1″·7	1″·8	1″·9	2″·0
Deflections	0	0	0	0	0	+3	+30	+12	+1	0

the results obtained in a typical experiment at 10° C., with the ventricle of the frog. The preparation was led off at apex and base, and excited close to the apex. The deflections represent the relative changes of potential at the apex contact. The authors reiterate the statement contained in their previous paper, that the electrical effect of excitation manifests itself in two phases, an initial and a terminal one, which have opposite signs, and further conclude that these two phases are separated by a relatively prolonged state of equipotentiality of the two apex contacts. These statements agree with those of Engelmann as far as they relate to the same period; but as the whole of the phenomena recorded by him belong to the beginning of the first second, the commencement of the period of equipotentiality is regarded by him as the end of the excitatory effect; but to the authors the absence of galvanometric effect during this isoelectrical interval is the expression of the fact that both contacts are in the same degree of excitation. The proof that this period of equipotentiality is one of balanced activities is obtained by subjecting the two led-off surfaces to different temperatures. If the apex be warmed the deflections of the terminal phase are increased, and commence at an earlier period; if the apex be cooled they are diminished. This is illustrated by the following table:—

Time after excitation, at which the galvanometer circuit was closed	0″·2	0″·4	0″·6	0″·8	1″·0	1″·2	1″·4	1″·6	1″·8	2″·0
Preliminary observation before warming	−30	0	0	0	0	+ 5	+23	+20	+ 5	0
Immediately after warming	−24	+17	+30	+71	+95	+99	+63	+ 9	+ 5	0
12 seconds later...	−25	+ 5	+ 2	+ 9	+25	+55	+52	+ 6	+ 2	0
24 seconds later...	−29	0	0	0	+ 6	+14	+50	+ 9	+ 2	0
36 seconds later...	...	0	0	0	+ 2	+ 7	+34	+14	+ 5	0
48 seconds later...	...	0	0	0	0	+ 5	+24	+16	0	0

Slight injuries, such as those produced by an application of a minute quantity of 10 per cent. salt-solution, resemble those effected by slight warming. If the injury is more complete, such as is produced by touching the surface momentarily by a red hot wire, the isoelectrical interval is as it were filled up; large deflections in which the warmed surface appears to be positive being obtained throughout the whole of the excitatory period excepting the first tenth. This is seen in the following table:—

Time after excitation of opening of galvanometer circuit, the period of closure being 0″·18.	0″·2	0″·4	0″·6	0″·8	1″·0	1″·2	1″·4	1″·6	1″·8	2″·0
Deflection	+58·6	+85·3	+82·3	+75·0	+68·3	+62·3	+50·0	+31·8	+21·3	+4·1

As regards the period of diminished excitability, the experiments of Marey ("Physiol. Exp." ii. 1876, 85) are first discussed, some experiments are then given which establish—(1) That the duration of the period of diminished excitability agrees pretty closely with that of electrical activity, and (2) that it is similarly affected by changes of temperature.

The rate of propagation of the excitatory wave in a fresh preparation is about 130 mm. per second.

The facts above stated are consistent with the following theories:—1. Every excited part is negative to every unexcited part so long as the state of excitation lasts. 2. The local duration of the excitatory state, *i.e.* the time it lasts in each structural element, is measured by the time interval between the beginning of the initial and the beginning of the terminal phase of the variation. 3. When both contacts are at the same temperature and in all other respects under the same conditions, the local duration of the excitatory state is the same at both, consequently it begins and ends earlier at the leading off contact first excited than at the other, the initial and terminal differences expressing

themselves in the initial and terminal phases of the normal variation. 4. When one contact is warmer than the other the local duration of the excitatory state is less in the warmed than in the unwarmed surface. 5. If the surface near one contact is slightly injured, the local duration at the injured surface is diminished in the same way as when the temperature is increased, but if the injury is of such intensity as to destroy its surface, its most prominent effect is to diminish its electromotive activity.

In an appendix the authors briefly consider the results of slight inequalities produced by mechanical, chemical, or thermal conditions on the potential of the surface of the ventricle in the resting heart, and the influence of temperature on the excitability of the resting heart.

A full account of the experiments, the results of which were communicated to the Society, will be published in the *Journal of Physiology*.

May 27.—"On some Thermal Effects of Electric Currents," by William Henry Preece, General Post Office. Communicated by Prof. Stokes, Sec. R.S.

I have been engaged for some time past in experimenting on the thermal effects of electric currents, but the final results of those experiments are not sufficiently ripe at present to justify my bringing them before the Royal Society. I have, however, obtained one result which I believe to be sufficiently novel to justify a short preliminary note.

The most striking facts elicited by these experiments are:

1. The extreme rapidity with which thin wires acquire and lose their increased temperature.

2. The excessive sensibility to linear expansion which fine wires of high resistance evince.

Now as the rate of heating, and therefore of expansion and contraction, varies very nearly directly as the increment or decrement of the currents when these variations are very small, it occurred to me that if a long wire of small diameter and high resistance were attached to a sounding board or to the centre of a disk (such as one of those used for telephones and phonographs) and it formed part of a circuit conveying telephonic currents, sonorous vibrations ought to be reproduced.

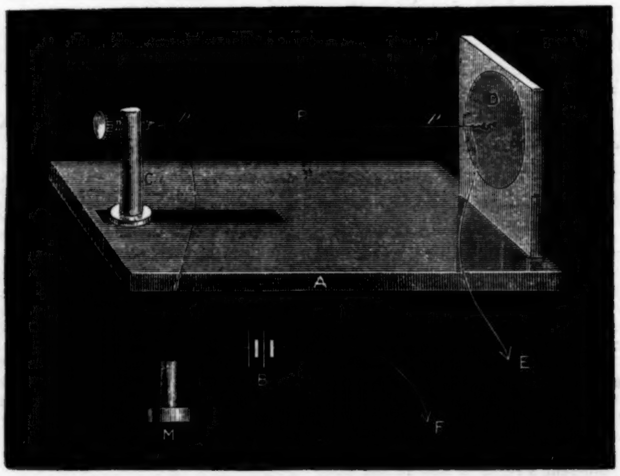
The sketch shows the arrangement of the apparatus used for the experiment.

A was a stout base of mahogany, on which a brass support C was attached so that it could slide and be fixed at any distance from D.

D was at first a disk of thin paper, and then of thin iron.

P was the wire experimented upon whose loose ends were connected to terminals on the wooden base, so as to be inserted in the circuit containing a microphone transmitter M and a battery B of six bichromate of potash cells in another room out of hearing.

A platinum wire of 0·003 inch diameter and 6 inches long from *p* to *p′* was first used, and the sonorous effects were most marked and encouraging when the microphone transmitter M



was spoken into. The articulation, though muffled, was clear, and words could easily be heard.

1. Experiments were first made to determine the length which gave the loudest sound and the clearest articulation, and, after repeated trials with every variation of length from 1 inch to 6 feet, it was found that a wire 6 inches long gave the maximum effect.

2. Experiments were then made to determine the diameter of the wire that gave the best effect, and after repeated trials with every gauge drawn from 0·0005 inch to 0·005 inch, it was found that wire of the diameter 0·001 inch gave the best effect.

3. Experiments were then tried with wires 6 inches in length and 0·001 inch diameter of different materials, viz., gold, iron, aluminium, silver, copper, palladium, and platinum, and they came out in the following order of merit:—

Platinum	Very clear.
Aluminium	Very variable.
Palladium	Clear.
Iron	Clear.
Copper	Faint.
Silver	Faint.
Gold	Very poor.

4. The effect of mechanical strain was tried. It was found not to vary the effect. When once the requisite tension, which varied with each metal, was obtained, further tightening up did not vary the clearness or loudness of articulation.

Gold would scarcely bear the tension required to reproduce sonorous vibrations, hence its low position.

5. Very thin carbon pencil, ·0625 inch diameter, was tried under compression and under tension, but no effect whatever was experienced unless a bad joint was made, when at once a faint microphonic effect was apparent.

6. No sibilant sounds whatever could be reproduced.

7. That the effect was due to heating and cooling was shown by the fact that it was possible to increase the current to such a strength as to render the temperature of the wire sensible to the touch, and then to make its elongation and contraction by low sounds evident to the eye.

It therefore appears from these experiments that wires conveying those currents of electricity which are required for telephonic purposes expand and contract as they are heated and cooled, and as the variations in the strength of the current are small compared with the strength of the current itself, the expansion and contraction vary in the same ratio as the condensation and rarefaction of the air particles conveying the sonorous vibrations which produced these vibrations.

The mechanical changes, or molecular vibrations in the wire, due directly or indirectly to telephonic currents, which result in the reproduction of sound, bear a close analogy to the mechanical changes due to the direct transmission of sound, but with this important difference, that while the vibrations due to sound are progressive along the wire, and their velocity is low and easily

measured, those due to thermal effects are practically instantaneous, and therefore affect simultaneously the whole length of the wire.

NOTE.—De la Rive, in 1843 (*vide* "Electricity," vol. i. p. 304), observed that an iron wire emitted sounds when rapid discontinuous currents were passed through it; but he attributed the effect to magnetism, for he failed to obtain the same effect in non-magnetic wires like platinum or silver.

Graham Bell found, in 1874, that a simple helix without an iron core emitted sounds, and (in 1876) that very distinct sounds proceed from straight pieces of iron, steel, retort carbon, and plumbago, when conveying currents.

Prof. Hughes showed that his microphone was reversible, that is, that it could receive as well as transmit sonorous vibrations.

Mr. Weisendanger (*Telegraphic Journal*, October 1, 1878) reproduced sounds on a microphonic receiver which he called a thermophone, and attributed the effect to its true cause, viz., the expansion of bodies under the influence of heat, which, in fact, is the explanation of all microphone receivers.

Ader reproduced speech by the vibrations of a wire conveying currents of electricity, but he found that only magnetic metals were effective, and therefore, like De la Rive, he attributed the result to magnetic agencies (*vide* Count du Moncel, *Telegraphic Journal*, March 1, 1879).

These and many other sonorous effects of currents on wires may be really due to such heat-effects as I have described.

Chemical Society, May 20.—Prof. H. E. Roscoe, president, in the chair.—The first paper was entitled, "On the Action of Air upon Peaty Water," by Miss Lucy Halcrow and Dr. Frankland. In consequence of the statements of Dr. Tidy in his paper on river-water, as to the rapid oxidation of peaty matter in running water, the authors have studied upon an experimental scale the action of exceptionally strong peaty water upon atmospheric air. The peaty water was exposed to air and light with and without agitation; the organic matter in the water and the oxygen in the inclosed air were determined before and after each experiment. It was found that minute quantities of oxygen were absorbed by the peaty water, but even when some water was shaken for ten and a half hours in a bottle fixed on the connecting-rod of a steam-engine making 100 strokes per minute, only 2¼ per cent. of the organic matter was oxidised, assuming that all the oxygen taken up was employed in the oxidation of organic matter. The authors therefore conclude that if peaty matter is oxidised the process takes place with extreme slowness.—Dr. Frankland then read a paper on the spontaneous oxidation of organic matter. This was practically a criticism of the conclusions drawn by Prof. Tidy in his paper alluded to above. The author first referred to the belief so prevalent twelve years ago that water polluted with sewage quickly regains its original purity by spontaneous oxidation, and explained how this belief was upset by the quantitative evidence obtained by the Second Rivers Pollution Commissioners in 1868. He then criticised the results of Prof. Tidy, and pointed out some grave inconsistencies therein. Thus the Shannon, after flowing twenty-three miles through Loch Derg, has its organic elements diminished about 18 per cent., whilst the next flow of a mile effects a diminution of 38 per cent. A sample taken four miles lower down showed an increase of 75 per cent., &c. These inconsistencies could only be explained by want of care in taking and securing an average sample of the river at the different points. The artificial purification of mixtures of sewage and water effected by Prof. Tidy by running water through a series of shallow troughs was then considered, and the chief cause of the diminution of organic carbon and nitrogen attributed to the decomposition of the urea into ammonium carbonate. The author concludes that there is no evidence whatever of the destruction by oxidation of the dead organic matter of sewage by a flow of a dozen miles or so in a river, still less is there any ground for assuming that the organised or living matter of sewage is destroyed under like circumstances. The paper concludes with some statistics as to the effect of the water-supply on the spread of epidemics of cholera, &c. Prof. Huxley pointed out that all diseases which are caused by so-called germs are caused by bodies of the nature of bacteria, and that these organisms were plants, and were therefore extremely unlikely to be oxidised or destroyed by endosmose, as suggested by Prof. Tidy, and that it was quite conceivable that a water containing such bodies might be perfectly pure from a chemical point of view, and yet be as deadly as prussic acid. Prof. Tidy, in reply, pointed to the statistics of the last ten years, which proved that many towns which derived their water-supply from river-water which had been polluted with sewage were as free from fever, &c., as other towns supplied by deep-well water.

Physical Society, May 22.—The annual holiday meeting of this Society was held at Cambridge. On arrival there the party partook of luncheon in a hall of St. John's College, which had been kindly arranged for the purpose by the College authorities. Prof. W. G. Adams occupied the chair, and Mr. Warren De la Rue proposed a vote of thanks to the Master and Senior Fellows of the College for providing the hall. The vote was heartily accorded by the members, and after some remarks from Prof. Adams the party proceeded to the Cavendish Laboratory, where Lord Rayleigh, as vice-president of the Society, presided. The routine business of the meeting being waived, Lord Rayleigh described a plan for limiting the slit of a telescope so as to alter the angular interval with which it can deal. The interval is measured by means of a grating formed by winding a fine wire round two parallel screws of very fine thread.—Mr. Shaw exhibited a modification of Veinholdt's apparatus for distilling mercury, by which a kilogram of mercury can be distilled per hour.—Mr. Sydney Taylor exhibited a device for showing the motion of the particles of water in the transmission of a surface-wave. Sixteen disks were arranged in single file, each having a white spot on its face, and on turning a handle the disks rotated so that the spots, which represented particles of water, moved so as to present a wave-motion to the eye. Mr. Taylor also showed a manometric flame apparatus for exhibiting to the eye the difference of phase between two musical notes. This consisted in two bent tubes, into which the notes were sounded, and capable of being lengthened or shortened by hand like the pipes of a trombone. Opposite the ends of each of these tubes a sensitive flame was placed, and a rotating mirror showed the disturbance produced in the flames by the two different notes. A third flame exhibited the joint effect of the two notes. When the tubes were silent, the images of the flames on the revolving mirror were seen as plane bands; but when notes were sounded into the tubes they became serrated, and the serrations were like or unlike according as the phases of the notes were like or unlike.—Mr. Poynting exhibited a plan for altering the plane of polarisation of the two halves of a pencil of rays from the polariser, so that half the field may be made to appear dark when the other is bright, or both of equal brightness, at will.—Mr. Glazebrook described a method of measuring the rotation of the plane of polarisation of light by means of two spectra giving dark lines made to coincide.—Lord Rayleigh described a plan for demonstrating that yellow colour can be formed by combining red and blue together. He mixes a red solution of chromate of potash with a blue solution of litmus, and on pouring it into a glass cell of a certain thickness, the light transmitted through it is seen to be yellow. Plates of glass coated with gelatin impregnated with litmus and gelatin impregnated with chromate of potash and placed side by side also transmit yellow light. Lord Rayleigh finds, however, that the eyes of different persons vary considerably in their power of appreciating the tinge of the transmitted yellow, one deeming it greenish, another reddish, while a third considers it pure yellow. This peculiarity is not to be confounded with "colour-blindness," since all three persons would distinguish the red and green components accurately. Lord Rayleigh also exhibited a colour-box based on the Newtonian principle, first carried out by the late Prof. Clerk Maxwell, but of a small size.—Sir W. Thomson then proposed a vote of thanks to Lord Rayleigh, which was seconded by Prof. W. G. Adams, and the meeting then dispersed to examine the apparatus and appointments of the Cavendish Laboratory.

Meteorological Society, May 19.—Mr. G. J. Symons, F.R.S., president, in the chair.—Messrs. T. H. Edmonds, F. Ekless, A. H. Taylor, and T. Turner were elected Fellows of the Society.—The following papers were read:—Variations in the barometric weight of the lower atmospheric strata in India, by Prof. E. Douglas Archibald, M.A., F.M.S.—A sketch of the winds and weather experienced in the North Atlantic between lats. 30° and 50° during February and March, 1880, by Charles Harding, F.M.S. The period embraced in this paper includes the time during which H.M.S. *Atalanta* was on her homeward passage, as she left Bermuda on January 31. From the data collected it is shown that a gale blew in the Atlantic every day throughout the two months, excepting on February 21 and 24 to 27. With especial reference to H.M.S. *Atalanta* it appears probable that she would not have met with any exceptionally

severe weather earlier than about February 12 or 13, and allowing that she had averaged from five to six knots per hour on her homeward course, she would at that date have inevitably encountered a severe hurricane. A heavy gale is noted on the 12th in 38° N. and 45° W., which is in the direct homeward-bound track from Bermuda, and if the *Atalanta* had only averaged four knots per hour on her homeward course she would have fallen in with this gale. The storm of the 12th and 13th may fairly be considered as about the most severe during the two months here dealt with. It may be remarked that the Norwegian barque *Caspaei* was north of Bermuda on the 3rd, and was in the full force of the gale on the 12th; her distance made shows that the winds were favourable for a homeward passage from Bermuda. The correspondence from H.M.S. *Salamis*, published in the *Times* of May 6, states, on the authority of the captain of the *Caspaei*, "on February 12, in lat. 42° 43' N., long. 39° 25' W., while running before the wind, encountered the severest gale he had ever experienced. The ship would not steer, and could not be prevented from broaching to. She was thrown on her beam ends, and remained so for nineteen hours, the cargo of cotton keeping her afloat. Several ships were in sight at the time of the commencement of the gale, and were unable to lay to on account of its suddenness."—On the meteorology of Mozufferpore, Tirhoot, for the year 1879, by Charles N. Pearson, F.M.S.—Mr. D. Winstanley also exhibited his solar radiometer.

Mineralogical Society of Great Britain and Ireland, June 1.—General Meeting.—Prof. T. G. Bonney, F.R.S., vice-president, in the chair.—Messrs. G. Neist Walker, F.G.S., Alex. Murray, F.G.S., director of the Geological Survey of Newfoundland, Geo. S. Mackenzie, Ph.D., and Hjalmar Furuhjelm, Government Inspector of Mines, Helsingfors, were elected as Ordinary Members, and Mr. Robert M. Heddle was elected as an Associate.—The following papers were read and discussed:—On a new face on crystals of stilbite from Scotland and Western Australia, by Prof. M. F. Heddle, F.R.S.E.—On a portable chemical apparatus for quantitative work, by A. E. Arnold.—On kaolinite and kaolin, by J. H. Collins.—On new Scottish minerals, by Prof. Heddle.—Further notes on mineral growth, by T. A. Readwin.—Interesting specimens of minerals were exhibited by Messrs. F. W. Rudler, T. A. Readwin, J. R. Gregory, and Wm. Summers.—The next meeting of the Society will be held at Swansea in August, during the "British Association" week.

PARIS

Academy of Sciences, May 31.—M. Edm. Becquerel in the chair.—The following papers were read:—On an automatic electric lamp, by M. Jamin. A development of the "burner" described before. Three pairs of carbons are set pendant within an oblong covered coil; one pair, having its points nearer than the others, gives rise to the arc first, and burns upwards, and when it is consumed the fusion of a brass wire causes the second pair to come into action (similarly with the third). The expenditure in horse-power and the total light increase up to nine lamps, then both diminish. (Numerical results are fully given.) The brightness of the points directed down is five times that the other way.—On the heat of combustion of the principal hydrocarbonised gases, by M. Berthelot. *Inter alia*, the heat in question is never equal to that of the component elements, and M. Berthelot indicates the nature of the differences.—On the cosmogonic ideas of Kant, *apropos* of a reclamation of priority by M. Schlötel, by M. Faye. He finds no similarity between M. Schlötel's citations from Kant and his own special ideas.—M. Bresse was elected Member in Mechanics in place of the late General Morin.—Synthesis of citric acid, by MM. Grimaux and Adam.—Researches on the albuminoid matters of crystallin as regard the non-identity of those that are soluble with the albumen of white of egg and of serum, by M. Béchamp. In the soluble part he finds two quite distinct albuminous matters (*phacozymase* and *crystalbumin*), and distinctly separates the insoluble matters of the crystallinian fibres from fibrine. He laid special stress on direct analysis and determination of rotatory power, regarding coagulation as of secondary importance.—On the use of volcanic sands in treatment of vines attacked by phylloxera, by M. Novi.—A list of memoirs sent in prize-competition was given.—The Secretary described M. de Candolle's work on "Phytography, or the Art of Describing Plants."—On the refractions of Bessel, by M. Radau.—On an extension to functions of two variables of Riemann's problem relating to hypergeometric functions, by M. Picard.—On a class of two functions doubly periodic, by M. Farkas.—Determination of three axes of a solid body on which centrifugal forces exert, through rotation, a maximum effect, by M. Brassinne.—On the equilibrium of elasticity of a rectangular prism, by M. Mathieu.—Telephone with magnetic superexcitation, by M. Ader. This is based on the principle that if a thin layer of iron or steel be placed before the poles of a magnet it is much more powerfully affected if an iron armature be placed behind than if the latter be not present.—Study of the distribution of light in the spectrum, by MM. Macé and Nicati. Two quantities of light are considered equal when, illuminating a given colourless object placed always at the same distance from the same observer, they enable him to perceive the details with the same distinctness.—On astigmatism, by M. Leroy. Heat liberated in the combustion of some isomeric alcohols of the fatty series, and of œnanthol, by M. Longuinine. Isomerism of substances having the same chemical function, but differing in internal structure, does not appreciably affect their heat of combustion and formation.—On freezing mixtures formed of two crystallised salts, by M. Ditte.—Crystallised hydrofluosilicic hydrate, by M. Kiessler.—Proportion of carbonic acid in the air; reply to M Riset, by M. Marié-Davy.—Preparation of malonic acid, by M. Bourgoin. He has simplified and improved the process.—Preparation of neutral sulphuric ether, by M. Villiers.—Presence in *Soja hispida* (Münch.) of a notable quantity of a substance soluble in alcohol, and easily transformable into glucose, by M. Levallois.—Functions of the swimming bladder of fishes, by M. Marangoni. It rules the migration of fishes. They have to counteract its action with their fins. It produces a double instability, one of level, the other of position.—Researches on the structure of the axis below seminal leaves in cotyledons, by M. Gérard.—Journey from Biskra among the Touaregs, by M. Roche. This gives some geological details.—On the structure and development of the dentinary tissue in the animal series, by M. Magitot.—On the mucus of the cloacal region of the rectum, by MM. Herrmann and Desfosses.—On the inoculability of symptomatic *charbon*, and the characters which differentiate it from splenic blood, by MM. Arloing, Cornevin, and Thomas. The microbe by which the disease is transmitted is quite distinct from the *Bacillus anthracis*.—On M. Rohlfs' journey of exploration into the Eastern Sahara, by M. Berlioux.—French explorations in Central Africa, by M. Fontane. One of the two proposed scientific and hospital stations (the eastern one) is to be established at Kirassa, near Kiora, about 250 km. from Bagamoyo; and Capt. Bloyet, who is to superintend it, has left Marseilles with that object. M. Savorgnan de Brazza has been charged to explore the region about the sources of the Ogooué, and fix a point for the western station; Dr. Ballay accompanies him.—M. Jimenes presented a celestial map projected on the horizon of Mexico.

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